CANADA
DEPARTMENT OF MINES
HON. ARTHUR MEIGHEN, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER.

GEOLOGICAL SURVEY
WM. MCINNES, DIRECTOR.

MEMOIR 119

No. 101, GEOLOGICAL SERIES

The Reed-Wekusko Map-Area Northern Manitoba

BY
F. J. Alcock

OTTAWA
THOMAS MULVEY
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1920

No. 1821

PLATE

Paragneiss, Loonhead lake. (Page 21.)

6543

Plate I.

CANADA

DEPARTMENT OF MINES

Hon. Arthur Meighen, Minister; Charles Camsell, Deputy Minister.

GEOLOGICAL SURVEY

Wm. McInnes, Director.

MEMOIR 119

No. 101, Geological Series

The Reed-Wekusko Map-Area Northern Manitoba

BY

F. J. Alcock

OTTAWA

THOMAS MULVEY

PRINTER TO THE KING'S MOST EXCELLENT MAJESTY

1920

6543 No. 1821

CONTENTS.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

Illustrations.

The Reed-Wekusko Map-area, Northern Manitoba.

CHAPTER I.

INTRODUCTION.

GENERAL STATEMENT.

The discovery of gold-bearing quartz veins at Amisk lake, Saskatchewan, in the summer of 1913, drew attention to the areas of basic Precambrian rocks in northern Manitoba and Saskatchewan. One belt of such rocks was known to extend from Amisk lake eastward to Wekusko lake, Manitoba, a distance of approximately 125 miles. In 1914, gold-bearing veins were found on the east shore of Wekusko lake and in 1915 a deposit of copper and zinc sulphides was discovered at Flinflon lake, between Amisk and Athapapuskow lakes. In the same year a rich sulphide deposit which afterwards became the Mandy mine was found at Swchist lake north of lake Athapapuskow. On account of the gold discovery at Amisk lake, E. L. Bruce, of the Geological Survey, began the areal mapping of the district in 1914 and a report entitled the "Amisk-Athapapuskow Lake district," summarizing the result of the work of four field seasons, was published in 1918. The Reed-Wekusko Lake area adjoins the Amisk-Athapapuskow area. Practically the whole belt of promising rocks is included in the district shown on these two map-sheets.

FIELD WORK.

The field work upon which the present report is based was done during the seasons of 1917 and 1918. Surveys of lakes and canoe routes throughout the area were made by means of the Rochon micrometer and surveyor's compass, with telemeter surveys substituted on portages and winding streams. Ties with the 17th and 18th base-lines were made wherever possible. The smaller lakes and streams which could not be reached by canoe were located by pace and compass traverses, with ties wherever possible to more than one fixed point.

ACKNOWLEDGMENTS.

Thanks are due to many people at Wekusko lake for information concerning the area. Special mention should be made of Messrs. J. P. Gordon, H. Vickers, R. MacLeod, and R. Woosey. The writer is also indebted to Mr. George Morton, of Reed lake, for information as to the western portion of the area and for other courtesies. A transit and chain survey of the road from Mile 82 on the Hudson Bay railway to Wekusko lake was kindly supplied by Mr. Gordon. Assistance in the field was efficiently rendered by F. M. Wolverton and M. E. Roberts in 1917, and by A. M. Corley in 1918.

LOCATION AND AREA.

The Reed-Wekusko Lake district (Map 1801) lies in northern Manitoba; its northern and southern boundaries are approximately 55° and 54°30′ north latitude respectively; its eastern and western boundaries are respectively ranges 13 and 22, west of the principal meridian. The map-sheet covers a rectangular area 56 miles long east and west and 30 miles north and south; its area is, therefore, 1,680 square miles. The nearest town is The Pas, Manitoba, and the nearest railway point is Mile 82 on the Hudson Bay railway.

MEANS OF COMMUNICATION.

Prior to the construction of the Hudson Bay railway, Reed and Wekusko lakes were reached from The Pas either by way of Saskatchewan river, Cumberland, Namew, and Athapapuskow lakes, and Grass river, or by a shorter route by way of Cormorant lake. The Cormorant Lake route leaves Saskatchewan river at a portage about 4 miles below The Pas, follows Frog river, Cormorant lake, and Cowan river, and then crosses a number of small lakes and portages to Reed lake.

Since 1914 the Hudson Bay railway has greatly facilitated access to the area. A canoe route leaves the railway at Mile 41.5 and follows the route already mentioned across Cormorant lake and up Cowan river. A winter road leads from Mile 55 to Reed lake.

The main means of communication with the railway, however, is a road $10\frac{3}{4}$ miles long which runs from Mile 82 on the railway to the south end of Wekusko lake. Before the completion of this road, a winter trail 14 miles in length from Mile 86 to the south end of Wekusko lake was used, and a summer road, made in 1917, followed part of this trail. A route used before that time led from Mile 116 on the railway, down Kiski creek to Setting lake and up Grass river over nine short portages to Wekusko lake. There is a roadhouse at each end of the road connecting Mile 82 on the Hudson Bay railway with the south end of Wekusko lake, and a store has been opened on the east shore of Wekusko south of the Rex property.

HISTORY.

GENERAL HISTORY.

The early history of the region and of western exploration in general is largely the history of the fur trade. In the year 1670, a charter was granted by King Charles II of England to the Governor and Company of Adventurers trading from England to Hudson bay, now the Hudson's Bay Company, giving them the monopoly of the trade, fisheries, minerals, etc., of all the lands bordering on Hudson bay. In return the company guaranteed to govern and defend the territory. Trading posts were established at the mouths of the more important rivers flowing into the bay and the Indians were induced to bring their furs to these points to trade. The French of the St. Lawrence region were also interested in the fur trade and posts were established by them at Sault Ste. Marie and Michilimachinac. Their explorers proceeded westward from lake Superior to lake of the Woods and lake Winnipeg, ascended Saskatchewan river, and in 1742 reached Missouri river which they in turn ascended to an eastern spur of the Rocky mountains.

When Canada in 1759 became a British province a great many English speaking merchants, the majority of them of Scottish descent, came to Montreal. They soon found the fur trade of the interior to be very profitable and it was not long before their voyageurs rediscovered the old French canoe routes and penetrated even farther into the northwest. In 1772, a post was established by Joseph Frobisher and his brother on Cumberland lake to intercept the fur brigades from the Athabaska-Mackenzie region on their way to Hudson bay. Two years later Samuel Hearne of the Hudson's Bay Company established Cumberland House 2 miles below this post. In 1784, the various Montreal companies united to form the North-West Company which remained the great rival of the Hudson's Bay Company until their union in 1821. The rivalry in the establishment of trading posts at strategic positions led to a great amount of exploration, and the early maps of the country were prepared either by the traders themselves, for example, Peter Pond and Sir Alexander Mackenzie, or by surveyors such as Peter Fidler and David Thompson working for the companies.

Grass river was one of the early canoe routes. On Pond's map dated 1785, it is marked as the "middle road to Hudson's bay". The first fairly accurate survey was begun in 1791 by David Thompson who descended the river as far as Reed lake and from there crossed by way of Methy and File lakes to Burntwood river.

PREVIOUS WORK.

In 1896, J. B. Tyrrell made a reconnaissance survey of Grass river, and a description of the geology of the region is given in reports by him and D. B. Dowling.[1]

A report on the basins of the Nelson and Churchill rivers, by Wm. McInnes, contains a general description of the geology of the region.[2]

In 1914, a reconnaissance trip was made by E. L. Bruce from Amisk lake to the Hudson Bay railway.[3] In 1916, a micrometer survey of the shore-line of Wekusko lake was made.[4]

In 1913, the 18th base-line was cut across a portion of the area as far west as Herblet lake by G. H. Herriott. In 1913, the 17th base-line was cut as far west as Reed lake by O. Rolfron and in 1918 it was continued westward by T. Plunkett.

BIBLIOGRAPHY.

Alcock, F. J.—"Wekusko Lake area, northern Manitoba," Geol. Surv., Can., Sum. Rept., 1917, pt. D, p. 8.

"Reed-File Lakes area, northern Manitoba," Geol. Surv., Can., Sum. Rept., 1918, pt. D, p. 6.

"Wekusko Lake area, northern Manitoba," Geol. Surv., Can., Sum. Rept., 1918, pt. D, p. 9.

"The origin of the gold deposits of Wekusko lake," Bull. Can. Min. Inst., Sept., 1918.

[1] Geol. Surv., Can., vol. XIII, pts. F and FF.

[2] Geol. Surv., Can., Mem. 30.

[3] Bruce, E. L., "Amisk Lake district, northern Saskatchewan and Manitoba", Geol. Surv., Can., Sum. Rept. 1914, pp. 67–68.

[4] Bruce, E. L., "Schist Lake and Wekusko Lake areas, northern Manitoba", Geol. Surv., Can., Sum. Rept., 1916, pp. 159–169.

Bancroft, G. R.—"Prospecting opportunities in Manitoba," Bull No. 87, Can. Min. Inst., pp. 719-720.

Bruce, E. L.—"Amisk-Athapapuskow Lake district," Geol. Surv., Can., Mem. 105.

"Amisk Lake district, northern Saskatchewan and Manitoba," Geol. Surv., Can., Sum. Rept., 1914, pp. 67-69.

"Amisk-Athapapuskow Lake area, northern Saskatchewan and Manitoba," Geol. Surv., Can., Sum. Rept., 1915, pp. 126-130.

"Schist Lake and Wekusko Lake areas, northern Manitoba," Geol. Surv., Can., Sum. Rept., 1916, pp. 159-169.

"District lying between Reed lake and Elbow lake, Manitoba," Geol. Surv., Can., Sum. Rept., 1918, pt. D, p. 2.

"A new gold area in northern Saskatchewan and Manitoba," Trans. Can. Min. Inst., vol. 18, 1915.

"Mining in northern Manitoba," Can. Min. Inst., Bull. No. 71, pp. 262-270, Mar., 1918.

"Prospecting areas in Manitoba," Manitoba Pub. Sc. Bull., June, 1919.

Campbell, J. A.—"Northern Manitoba," Rept. of the Commissioner of northern Manitoba.

"Manitoba Northland," Rept. of the Commissioner of northern Manitoba.

"Copper and gold in Manitoba," Can. Min. Jour., vol. XXXVIII, No. 13, pp. 274-276.

"Mining in northern Manitoba," Can. Min. Jour., vol. XXXIX, No. 16, p. 273.

"Recent discoveries and developments in northern Manitoba," Can. Min. Jour., vol. XXX, No. 21, p. 360.

DeLury, J. S.—"The mineral belt north of The Pas, Manitoba," Can. Min. Jour., vol. XXXVII, No. 17, pp. 412-414.

"Recent developments in Manitoba," Can. Min. Jour., vol. XL, No. 38, pp. 712-713.

Dowling, D. B.—"Geological explorations in Athabaska, Saskatchewan, and Keewatin districts," Geol. Surv., Can., Ann. Rept., vol. XIII, pt. FF.

Harding, W. K.—"Field for the prospector in Manitoba," Min. and Eng. World, vol. XLIV, No. 22, pp. 993-996.

Kitto, F. H.—"New Manitoba district," Natural Resources Intelligence Branch, Dept. of Interior.

McInnes, Wm.—"Explorations along the proposed line of the Hudson Bay railway," Geol. Surv., Can., Sum. Rept., 1906, pp. 87-98.

"The basins of Nelson and Churchill rivers," Geol. Surv., Can., Mem. 30.

Tyrrell, J. B.—"Explorations in the northeastern portion of the district of Saskatchewan and adjacent parts of the district of Keewatin," Geol. Surv., Can., Ann. Rept., vol. XIII, pt. F.

"Thompson's narrative of his explorations in western America," Champlain Society.

Wallace, R. C., and Delury, J. S.—"The mineral belt north of The Pas, Manitoba, in 1917," Bull. No. 54, Can. Min. Inst., pp. 884-890.

Wallace, R. C.—"Mining situation in Manitoba in 1917," Bull. No. 69, Can. Min. Inst., Jan., 1916, p. 33.

"Mining in Manitoba in 1918," Bull. No. 1, Jan., 1919, Can. Min. Inst., pp. 17-19.

"Mining development in northern Manitoba," Bull. No. 83, Can. Min. Inst., March, 1919, pp. 287-302.

"Mining in northern Manitoba in 1918," Can. Min. Jour., vol. XXXIX, No. 24, p. 422.

"Developments in northern Manitoba," Can. Min. Jour., vol. XL, No. 7, p. 109.

"The northern Manitoba field," Can. Min. Jour., vol. XL, No. 29, p. 549.

"Progress in the northern Manitoba mineral belt," Can. Min. Jour., vol. XL, No. 45, pp. 843-845.

CHAPTER II.

SUMMARY AND CONCLUSIONS.

GENERAL CHARACTER OF THE DISTRICT.

The Reed-Wekusko Lakes area is situated along that part of the southwestern margin of the Canadian Precambrian shield bordered by flat-lying Palæozoic sediments. The southern part of the map-area has an average width of about 8 miles and is underlain by Ordovician dolomite which presents a low escarpment facing the Precambrian rocks to the north along much of its length. The plateau has an average elevation in the area of about 950 feet; its surface is uneven and hummocky, with few elevations rising to heights of 100 feet above the general level. The low relief is a physiographic feature of pre-Ordovician age, the present surface being largely a result of the stripping off of the Palæozoic sediments. The region in Pleistocene times was overridden by continental ice-sheets that smoothed down the topographic features, polished and striated many of the rock surfaces, and deposited a thin, discontinuous mantle of drift.

The drainage was disorganized by glaciation. Old channels were blocked by the deposition of drift giving rise to lakes, and the new channels connecting the lake expansions are marked by gorges, rapids, and waterfalls. There is a close relation between the geology of the area and the drainage. The lakes for the most part lie in the softer schists and gneisses whereas the interstream areas are composed largely of the more resistant granite. In many places the older complex forms a mere fringe along the lakes and stream courses.

The population of the area is very limited and is confined to a few families on Reed and Wekusko lakes. The chief industry is fishing and since the opening of the Hudson Bay railway there has been a steady export of fish from the region. A limited amount of trapping is still carried on. Agriculture is confined to the raising of garden vegetables for local use.

GENERAL GEOLOGY.

The unconsolidated deposits of the area are glacial drift, stratified clays laid down in glacial Lake Agassiz, and recent deposits of peat. The solid rocks upon which these rest belong to two geological eras; Ordovician dolomite covers the southern part of the district, resting unconformably on a complex of Precambrian rocks exposed over the greater part of the area. The Precambrian rocks fall into two main groups, granite and its differentiates, and a pre-granitic complex of igneous and sedimentary rocks which have been altered by both contact and regional metamorphism.

The pre-granitic complex may be divided into two groups, one dominantly igneous and the other dominantly sedimentary. The igneous division consists largely of volcanic rocks varying in composition from rhyolite to basalt; it also includes intrusives with the composition of diorites and dykes of lamprophyre. Beds of pyroclastics, formed from volcanic ash and bombs, are found interbedded with the flows. Many of the flows show amygdaloidal and ellipsoidal structures. The rocks are all altered; the feldspars are changed into sericite, epidote, and carbonate and many of the original ferromagnesian minerals are changed into chlorite and uralite. Hornblende, biotite, and chlorite schists are the common products of the metamorphism of the intermediate and basic members of the division; the more acid types, consisting of rhyolite, quartz porphyry, and syenite porphyry are commonly altered into sericite schists.

The sedimentary division consists mainly of garnet gneiss and mica schist with local bands of conglomerate and slate. The most abundant rock type is a grey to rusty-weathering gneiss consisting chiefly of quartz, feldspar, and biotite. The mica schists associated with the gneisses include garnet-staurolite and cyanite-bearing varieties. The fine character of the banding, the continuity of the bands, the presence of abundant alumina-bearing minerals, and the association with undoubted clastic sediments are considered sufficient evidence for concluding that at least the greater part of these gneisses are sedimentary.

East of Wekusko lake several bands of conglomerate interstratified with volcanic rocks are associated with feldspathic quartzite and sedimentary gneiss. The beds are nearly vertical and have a matrix similar to the garnet gneiss of other parts of the area. The finer-grained portion is fairly well-bedded and in many places is crossbedded. The great thickness of the series,the dominance of clastic beds in which feldspar is abundant, the absence of limestone, the repeated conglomerate horizons, the presence and character of the crossbedding, and the interbedded volcanic flows point to a continental origin for these rocks. Though the conglomerate contains boulders of granite no proof was found in the area of an older granite upon which the beds might rest.

Granite and granite-gneiss intrusive into the above rocks occupy the greater part of the area. Many varieties differing in both mineralogical and chemical composition are found. Massive, reddish granite is the most common variety, but in places gneissoid types occur. Mineralogi-

cally the types include hornblende granite, biotite granite, and binary varieties. Along the borders of many of the stocks the intrusive is commonly darker in colour and has the composition of a quartz-diorite. Along the edges of other stocks the granite maintains its uniform appearance and composition to the actual contact, but contains numerous stoped blocks of the intruded formations. Pegmatite dykes, some of large size, are abundant along the borders of the intrusions and cut both the intrusive and the intruded rocks. Quartz veins represent the last phases of the intrusion.

Ordovician dolomite in the southern part of the area lies unconformably on the Precambrian rocks. It is thick-bedded, has a yellowish grey colour with certain of the lower beds reddish. Some fossils, chiefly corals and brachiopods, were collected and identified as Trenton in age.

The Pleistocene deposits overlying the Precambrian and Palæozoic rocks consist of a thin, discontinuous mantle of drift, thickest in the depressions and along the cliffs that face southwest. Sand-plains representing outwash deposits from the front of retreating ice-sheets are found locally. Lake clays deposited in glacial Lake Agassiz cover much of the area.

ECONOMIC GEOLOGY.

The chief ore deposits of the region are gold-bearing quartz veins. Active prospecting began in the summer of 1914 since which time many claims have been staked. A considerable amount of development work has been done. On one property, the Rex, a mill was erected and active mining operations were carried on in 1918; owing to a number of adverse conditions, work was discontinued in December, 1918.

The quartz veins, the youngest Precambrian deposits of the region, are found traversing all the rocks of the area with the exception of the Ordovician dolomite. The more important deposits located are situated along the northeast shore of Wekusko lake near the border of a granite stock that lies between Little Herb bay and Grass river and has a diameter of about 6 miles. Such small areas of granite represent the irregular, upper parts of large batholiths and are more promising grounds for prospecting than are the borders of large areas of granite representing batholiths exposed by deep erosion. The wider the areas of granite, the deeper the erosion has gone and the greater the likelihood of the complete removal of any associated mineral deposits.

Small deposits of molybdenite and galena, but none of commercial importance, have been found in the area.

CHAPTER III.

GENERAL CHARACTER OF THE DISTRICT.

TOPOGRAPHY.

GENERAL ACCOUNT.

Regional.

The Reed-Wekusko Lake area lies along the dividing line between two physiographic provinces, the Laurentian plateau on the northeast and the Great Plains on the southwest. The plateau is a great V-shaped area occupying approximately 2,000,000 square miles of central and eastern Canada and throughout its wide extent presents remarkably uniform features of low relief and disorganized drainage. In northern Manitoba the plateau has a maximum elevation of about 1,200 feet and slopes gently eastward to Hudson bay. Though the relief varies only from about 100 to 200 feet the surface is rugged and hummocky, consisting of low ridges separated by depressions in which lakes and muskeg swamps are common features. There are no high elevations and few hills rise more than 200 feet above the level of the adjacent lakes and streams. The irregular deposition of drift by the Pleistocene glaciers has disarranged the drainage with the result that the country is dotted with lakes of all sizes and most irregular outline. Many of the rivers are mere chains of lakes connected by short stretches of water in which rapids and waterfalls are numerous. It is a region which was eroded to a peneplain in pre-Ordovician time but which, owing to glaciation and uplift, today presents many of the features of youthful topography.

West of the Reed-Wekusko Lake area lies the broad physiographic province known as the Great Plains, a rolling prairie country developed on nearly flat-lying sedimentary rocks. The southern portion of this province in Canada is divided into three steppes by two eastward facing escarpments. The first, known as the Manitoba lowland, comprises the country surrounding lake Winnipeg. It is underlain by Palæozoic rocks and is bounded on the west by an escarpment of Cretaceous rocks known as the Manitoba escarpment. West of this escarpment the Cretaceous plains rise gently to the foothills of the Rocky mountains. The third steppe consists of a plateau of Tertiary rocks whose eastern border is an escarpment known as the Missouri coteau. The plateau is a remnant of more widely spread Tertiary rocks and since on its western side facing the Rocky mountains there is a drop equal to that on the east, the Missouri coteau does not mark a rise from one level of the plains to another as does the Manitoba escarpment.

Local.

The greater part of the Reed-Wekusko Lake area belongs to the Laurentian plateau and presents the features characteristic of it, including low relief, hummocky topography, streams marked by lake expansions, rapids, and waterfalls, lakes with irrregular outlines, and numerous islands, and other features due to glaciation. Along the southern margin of the area, however, there is a belt of flat-lying Ordovician dolomite. The actual border is in many places a low escarpment varying in height up to 80 feet facing the Precambrian rocks. The escarpment has a very irregular outline with deep re-entrant angles, and small outliers occur north of it. In many places, instead of an abrupt escarpment the rise from the surface of the Precambrian rocks to that of the upper limestone beds is by a series of low steps of varying width. Owing to the fact that the dolomite beds are horizontal, the surface is comparatively flat and smooth in contrast with the hummocky Precambrian country. Much of this flat-lying portion is muskeg. The eastern portion of the area was covered in late Pleistocene time by glacial Lake Agassiz from which deposits of lacustrine clay have locally modified to a considerable degree the rugged Precambrian topography.

DETAILED ACCOUNT.

Relief.

The average elevation of the Precambrian part of the Reed-Wekusko Lake area is approximately 950 feet. The highest elevation on the 18th base-line as far west as Herblet lake is 1,016 feet and on the 17th base-line east of Reed lake is 975 feet. The divide between the drainage basin of File river on the west and the basins of Squall and Little File rivers on the east reaches an elevation of 1,060 feet. Few, if any, hills in the area attain an elevation of 1,100 feet. The lowest point in the area, on Grass river which drains the entire district, is 818 feet. The eastward slope of that part of the plateau contained within the sheet is approximately 3½ feet per mile. The detailed relief in the area is not as great as that displayed in many portions of the Precambrian plateau, the average elevation of the plateau surface above the adjacent lakes being about 50 feet and only seldom exceeding 100 feet.

Relation to Geology and Structure.

The topography of the region is in close harmony with the geological structure. The dominant trend of the rocks is northeast and their general direction is expressed by parallel strike ridges and by the main drainage lines. Where lakes or valleys lie transversely to this direction structure is usually the cause. Snow lake and Puella bay on Wekusko lake, are examples of depressions that run in a northwest direction along the strike of the adjacent rocks.

There is also a close relation between the topography and the type of bedrock. As a rule, the streams and lakes lie in the softer gneisses and schists, whereas the interstream areas are composed of the more resistant granite. In many cases the lakes are bordered by a narrow fringe of older rocks and the large interlake areas are composed entirely of granite and granite-gneiss. The outline of the lakes is also frequently distinctive of the rocks outcropping along their shores. Lakes in schists and sedimentary gneisses have extremely irregular shore-lines with many small bays running parallel to the strike of the rocks. Lakes in granite areas are smoother in outline and the bays extend in any direction, but commonly follow the contacts with the intruded rocks. Both of these types of shore-line are well displayed on Wekusko, Woosey, Herblet, and other lakes throughout the area. Three of the four main bays of Herblet lake and their numerous indentations follow the strike of the gneisses; the fourth runs in a northwest direction parallel to a granite contact. The smooth outline of the western shore is typical of the granite areas, in contrast to the minutely irregular shores of the other bays. Woosey lake shows similar features. Its western arm has a smooth outline and extends northwestward along a granite contact; the rest of the lake, surrounded by schist, has the dominant northeast trend and the characteristic irregular outlines.

Drainage.

Both Reed and Wekusko lakes are expansions of Grass river and much the greater part of the area lies within the Grass River basin. The northwestern part, however, is drained by File river into Burntwood river which empties into the Nelson river at Split lake, about 7 miles north of the point where the Nelson is joined by Grass river.

Grass river rises in Cranberry lakes about 50 miles west of Wekusko lake; in this part it includes the lake expansions known as the Three Cranberry, Simonhouse, Elbow, Iskwasum, Reed, and Tramping lakes. From Wekusko lake the river flows in a northeasterly direction joining the Nelson about 7 miles south of Split lake, a distance in a straight line of approximately 150 miles. The more important lake expansions of this part of the river are Setting, Paint, and Partridge Crop lakes.

Of the smaller streams only three are sufficiently large to serve as canoe routes. Snow river forms a route to Herblet lake and to Snow and Squall lakes. A portage route also may be followed from Squall lake to File lake. Wekusko river forms an alternative route to Herblet lake, and from the eastern end of Reed lake a stream may be ascended to Morton lake.

Lakes and Swamps.

Eighteen per cent of the map-area is known to be covered by lakes. These vary in size from Reed lake with an area of 74 square miles to ponds covering only a few acres. A striking feature of many of them is the length of shore-line as compared with the comparatively small area. Wekusko lake has a shore-line of 126 miles and an area of 70 square miles; Herblet lake a shore-line 62 miles long and an area of only 12·5 square miles; File lake a shore-line of 56 miles and an area of 20 square miles; Woosey lake a shore-line of 36 miles and an area of only 6 square miles.

The shores are for the most part rocky. Locally, bold granite cliffs rise to a height of 50 to 75 feet; steep cliffs of schist are equally common but are seldom more than 30 feet in height; these are very irregular in outline and are commonly marked by a talus of coarse blocks. Few of the lakes are deep. Wekusko lake has a maximum depth of about 50 feet. Reed lake has a maximum depth of 108 feet at a point in the north bay leading to Morton lake; its average depth is about 10 feet.

Much of the area is covered by muskeg; in fact it is impossible to travel overland for any distance without traversing wet areas. The depressions between the ridges are commonly of that character and even the country underlain by granite consists for the most part of low knobs and ridges surrounded by swampy areas. Varieties of muskeg include the floating open bog without trees, the floating bog with a sparse growth of tamarack and black spruce, bogs with a thick growth of small spruce trees, open dry muskeg covered with moss, and dry muskeg areas with a dense growth of spruce. All gradations exist between these types and all the types may be found in close proximity.

GLACIATION.

The whole area shows abundant evidence of having been overridden by ice-sheets. The hills and ridges are rounded and nearly everywhere smoothed and striated rock surfaces are abundant. Deposition by the glaciers was confined to the dropping of scattered erratics and to local deposits of boulder clay in depressions and on the southwestward slopes of steep cliffs. Sand-plains, evidently outwash deposits from the front of retreating ice-sheets, occur at a number of places throughout the area.

Glacial striæ, showing varying directions of ice movement, were observed at numerous points. The dominant direction is south 23 degrees west, but a number of other sets were also recorded. On Ingram island in Reed lake, the direction is south 45 degrees west. Another set recorded on Morton lake, File lake, and at a number of points on Wekusko lake (Plate V) is south 13 degrees west. Other sets recorded at a few places on Wekusko lake are south 8 degrees west and south 7 degrees east. Some of these variations may be local and due to topographical features, but more probably they represent changes in the direction of advance of the ice.

The striæ show that the main advance was from the northeast. Evidence collected by McInnes[1] from a wider area suggests that in its retreat the ice-sheet divided into two lobes, one of which lay north of Wekusko lake and one to the east. Westerly striæ in the region east of Wekusko lake show that the eastern lobe advanced to within a short distance of Wekusko lake. Evidence in the Reed-Wekusko area suggests that the northern lobe also probably advanced once or more in a general southerly direction recorded by the striations south 8 degrees west and south 7 degrees east.

The amount of erosion accomplished by the ice-sheet was small. The Precambrian rocks were smoothed down and it is possible that some of the northeast valleys may have been deepened and widened. That

[1]McInnes, Wm., Geol. Surv., Can., Mem. 30, p. 118

little erosion was accomplished, however, is shown by the character of the surface of the Precambrian beneath the mantle of Palæozoic sediments. Profiles along the base of the Palæozoic sediments show that when these rocks were laid down the Precambrian surface was one of low relief with minor irregularity much like what is seen to-day. On the south shore of Wekusko lake where Ordovician dolomite extends down to the water's edge, greenstone cliffs locally stand out to a height of 20 feet showing these minor irregularities of the old Precambrian surface and are evidence that the present surface is largely a result of the stripping off of these sediments rather than the result of any great amount of planing by the Pleistocene glaciers. The ice, however, did probably aid in the removal of the Palæozoic rocks. As already mentioned the actual border of the Ordovician dolomite is a low escarpment with an irregular outline. The re-entrant bays extend in a direction parallel to glaciation and the highest cliffs also run parallel to this general direction. At a number of places it was observed that vertical cliffs locally 80 feet in height had a northeast trend while those parts of the escarpment running at right angles to this direction were low, rising in a series of low steps.

CLIMATE.

Records kept since 1910 at The Pas, the nearest point at which meteorological observations are available, show that for a period of six years from 1911 to 1916 the total annual precipitation including both rain and melted snow averaged 15.14 inches. The average rainfall for the months of June, July, and August for a period of seven years, was 7.23 inches, showing that a large part of the precipitation comes at the growing season when it is most required. In this respect it compares favourably with Winnipeg which had an average precipitation of 7.87 inches for these months during the same period. The average snowfall is about 35 inches.

The winters are long and cold; the summers are short and hot. During the growing months, however, the long days due to the higher latitude give a much greater amount of possible sunshine than in southern Ontario. The average monthly mean temperature for June, July, and August is a little higher than that at Prince Albert or at Edmonton. Observations by W. A. Johnston[1] along the Hudson Bay railway showed that in 1916 no killing frosts occurred from May 14 to September 14 and in 1917 none occurred from May 30 to October 3. The small lakes freeze over in October, but it is usually November before the larger lakes such as Wekusko and Reed freeze, and it is generally late in May and often early in June before they are free of ice.

AGRICULTURE.

Though agriculture has not as yet been attempted on any large scale, many gardens have been kept successfully. On five small islands in Wekusko lake over four hundred bushels of excellent potatoes were grown in 1917 besides a large quantity and variety of garden vegetables. At Reed lake, gardens situated both on islands and on the south shore have been equally successful.

[1] Johnston, W. A., Geol. Surv., Can. Sum., Rept., 1917, pt. D, p. 27.

POPULATION AND INDUSTRIES.

There is no population engaged in agriculture. A few white persons engaged in fishing and trapping live at Reed lake and Wekusko lake, and the development of the mineral properties has brought in some miners. The native population of the region consists of a few Cree Indian families, most of whom belong to The Pas settlement. Sometimes, however, Crees from the Burntwood River country come into the northern part of the area. A winter road leads from Grass river in the northeastern part of the map-area to Nelson House. Another route from the Burntwood leads by way of File river to File lake. Vickers lake near the northeast arm of File lake is a favourite camping site for these families. In earlier days there were undoubtedly many more natives than at present; on the west shore of the long northeast arm of File lake are the remains of an old, long-abandoned, trading post of the Hudson's Bay Company.

Fishing is an important industry during the winter months. Whitefish, trout, and pickerel are the most important fish caught. No lake trout are found in Wekusko lake although they are caught in Tramping and Reed lakes. Other species include pike, suckers, and goldeyes. The total amount of fish caught in the winter of 1916-17 in Wekusko lake, according to the annual report of the Fisheries Branch of the Department of Naval Service, was 1,507 hundredweight valued at \$8,640. Of this, whitefish was much the most important with a total value of \$5,831. In Reed lake during the same season the weight of fish caught was 309 hundredweight valued at \$2,093. Of this, trout amounted to 176 hundredweight valued at \$1,232, with whitefish next in order, value \$609.

The early exploration of the region was in connexion with the fur trade and for a long time fur was practically the only developed asset. Intensive trapping and forest fires have to a large extent depleted the fur-bearing animals, which include beaver, bear, otter, marten, mink, weasel, lynx, fisher, wolverine, wolves, foxes, and muskrats. Ducks are fairly abundant, grouse less so.

The most important game animals are moose which are fairly abundant throughout the area. A few woodland caribou are also found.

Examples of early native culture were found in the area. Plate VI shows photographs of a stone hammer, a stone pipe, a stone scraper, and a fragment of native pottery.

FORESTS.

Much of the region is forested, but considerable areas have been swept by fire. The best timber is derived from white spruce which forms large groves at many places along the lake. In the more poorly drained areas black spruce and tamarack are the common trees. Balsam commonly associated with the white spruce grows to a good size in places. Jackpine grows on the sandy areas and on rock ridges and is more typical of the granite districts. Of the deciduous trees the most important is aspen poplar which forms open forests in the better drained clay-covered areas. Birch is common, but for the most part the trees are small.

WATERPOWERS.

Grass river, the largest stream in the area, has a number of falls, the one with the greatest head being Wekusko falls lying between Tramping and Wekusko lakes. This has a head of 45 feet and during the summer months would be capable of developing considerable power. In winter, however, the flow of water is so small that it would be of little use for power development.

The nearest power site capable of producing throughout the year is Bloodstone falls on Churchill river, about 100 miles in a northeast direction from Wekusko lake. It has been estimated that 35,000 continuous 24-hour horsepower can be developed at the time of the minimum flow of the river. More detailed investigations have shown that with small additional expenditure for securing a higher head and a storage basin the output could be increased to 60,000 horsepower.

CHAPTER IV.

GENERAL GEOLOGY.

GENERAL STATEMENT.

REGIONAL.

The Reed-Wekusko Lake district lies on the southwestern margin of the Canadian shield, a vast area of Precambrian rocks the greater part of which consists of granite and granite-gneiss intruded as batholiths into older sedimentary and igneous rocks and later uncovered by long erosion in pre-Ordovician time. Here and there, however, areas of these older rocks have escaped erosion, and now prove to be most important both from a geological point of view, since they furnish the data from which the Precambrian history of the region may be deduced, and from an economic point of view, since it is in them that the mineral resources of the region occur. In the Lake Superior region, the Timiskaming region, and the Grenville region of Ontario and Quebec, such areas have received a great deal of geological attention both on account of their mineral wealth and the opportunities they give for the study of the Precambrian succession. In the broad portions of the plateau, however, lying in northern Manitoba, northern Saskatchewan, and the Northwest Territories such areas of older rocks are less abundant and, so far as is yet known, of smaller areal extent. Moreover, owing to the rapid reconnaissance character of the traverses across these belts, detailed knowledge concerning them is very limited.

LOCAL.

The superficial deposits which cover the solid rock formations consist of glacial drift, stratified lake clays deposited in post-glacial lakes, and more recent accumulations of peat in the muskegs and swamps. The drift deposits are thin and of local extent and the clay deposits are largely confined to the valleys in the eastern portion of the sheet; outcrops are consequently abundant throughout the area.

The solid rocks of the region belong to two geological eras. The greater portion of the area is underlain by rocks of Precambrian age; the remainder, a strip along the southern margin of the area, is underlain by Palæozoic dolomite. Between these two groups of rocks is an immense unconformity, the horizontal Palæozoic sediments resting on the eroded surface of the folded, metamorphosed, and intruded Precambrian rocks. The Precambrian rocks fall into two main divisions, (1) a complex of sedimentary and igneous rocks and (2) intrusives consisting largely of granite and granite gneiss cutting them. The igneous members of the complex are massive diorites, volcanic rocks varying in composition from rhyolite to basalt, autoclastics and pyroclastics and schists of various types derived from these rocks. The sediments associated with these igneous members are of iron formation, conglomerates, slates, quartzite, garnet gneiss, and mica schists containing staurolite, garnet, and cyanite. All these rocks are intruded by stocks and batholiths of granite, and by pegmatite dykes. Following this period of folding and intrusion there was a long interval of erosion during which the whole region was worn down to extremely low relief exposing the granite stocks and leaving mere remnants of the older rocks in the intervening areas. In Ordovician time this planated region was covered by a shallow sea in which were deposited beds of dolomite, remnants of which still mantle the Precambrian rocks of a portion of the area.

Table of Formations.

Quaternary.	Recent	Peat.
	Pleistocene	Stratified lacustrine clay. Glacial drift.
	Unconformity.	
Palæozoic..........	Ordovician	Dolomite.
	Unconformity.	
	Batholithic intrusives ...	Granite and its differentiates.
	Igneous contact.	
	Wekusko group	
Precambrian	Wekusko series	Mica schist.
		Garnet, staurolite, and cyanite-bearing varieties.
		Garnet gneiss.
		Greywacke, arkose, quartzite, conglomerate.
		Slate and phyllite.
	Kiski volcanics	Autoclastics and pyroclastics.
		Acid volcanics, including quartz-porphyry, rhyolite, and derived sericite schists.
		Basic volcanics (greenstones) including andesite, basalt, diorite, and derived chlorite, mica and hornblende schists.

WEKUSKO GROUP.

The Wekusko group includes a complex of volcanic and sedimentary rocks that have been closely folded and metamorphosed and intruded by granite batholiths. The rocks are comparable in lithology to groups described under local names in the Lake Superior and Timiskaming regions, but since both these districts are far from the area under discussion, no attempt at correlation has been made, and local names have been employed to designate the rock groups.

KISKI VOLCANICS.

The Kiski volcanics occupy no large areas in the region, and form for the most part merely fringes along the lakes. The basic or greenstone varieties are the most abundant, but a zone of rather acid rocks occurs along the east shore of Wekusko lake and has been separately indicated on the map because it contains the more important veins of the area. The rocks consist of flows, tuffs, breccias, intrusives, and schists derived from these types. Even the massive varieties are altered and in many of the thin sections all that is seen is a mass of secondary minerals that give little clue to the original character of the rocks.

Diorites.

Under this head are included the massive rocks of dioritic composition whose origin and relationships are not definitely understood. Some of them represent the coarse-grained, interior portions of thick flows and others may be intrusives. They are dark greyish-green, massive and altered rocks. A section of a massive variety from the west shore of Reed lake consists of labradorite feldspar and altered hornblende. The feldspar is for the most part fresh but is locally altered with the development of carbonate. All gradations exist between such coarse-grained types and true andesites. A massive rock collected 3 miles southeast of Puella bay, Wekusko lake, shows phenocrysts of plagioclase, a basic andesine in composition, in a groundmass of plagioclase, biotite, epidote, iron ore, and some quartz. The general term greenstone is used to include all these massive varieties.

Basic Flows.

Certain of the greenstone rocks can be identified definitely as volcanic flows from the presence of amygdaloidal and ellipsoidal structure. Both of the structures, however, are of only local occurrence. The amygdaloidal structure in particular is confined to the upper portions of the flows, and the remainder of the rock consists of massive rock with allotriomorphic or aplitic textures. In composition there is a wide range. A section of black, dense rock collected 2 miles east of the southern end of Cook lake consists largely of serpentine. Most of the flows, however, are of intermediate composition corresponding to andesites and dacites. Under the microscope they all are seen to be highly altered, consisting for the most part of a mass of secondary minerals; much of the feldspar is altered to sericite, carbonate, zoisite, and epidote and the original ferromagnesian

minerals are now represented largely by a light green, secondary hornblende. Small amounts of iron are usually present and chlorite in varying amounts, in some sections comprising the only or dominant ferromagnesian mineral. Shreds of brown biotite are commonly present and quartz in amounts depending on the composition of the flow.

In certain dark basic rocks, round masses of a yellowish green colour are abundant. These masses are usually less than one foot in diameter and have sharp boundaries against the dark rock in which they lie. In thin section they are seen to consist almost entirely of epidote with minor quantities of calcite, quartz, chlorite, and iron ore. They apparently represent segregations of ferromagnesian minerals which have subsequently been altered to epidote. Some of the best examples of these rocks were seen about 1¼ miles northeast of the northern end of Stuart lake.

The ellipsoidal or pillow structure presented by many of the flows is similar to that described as found in nearly all the areas of basic rocks in the Precambrian shield. It is most pronounced in the greenstone belt lying northwest of Anderson and Bear lakes. The ellipsoids vary from 6 inches to 4 feet in diameter. In thin section they are seen to consist of a green hornblende, andesine feldspar, quartz, biotite, and iron ore.

Four miles north of the point at which the 18th base-line crosses Grass river in the northeast corner of the map-area, is an outcrop of an ellipsoidal rock of a variety slightly different from the common one. The outcrop forms a low ridge rising from a flat, clay-covered stretch of country wooded with poplars and consists of masses of pillows varying in size from 6 inches to 3 feet in length. The striking feature about the outcrop is that though the outer borders of the ellipsoids and the intervening material consist of a dark grey rock, the interior of the ellipsoids grades into a white aphanitic rock with only a few dark crystals scattered sparingly through it. The dark borders consist dominantly of hornblende, pleochroic in shades of green; X = green, Y = pale yellow, Z = pale green, absorption $X > Z > Y$. A considerable portion of the feldspar is untwinned, but of this, most at least is plagioclase. Quartz is present in subordinate amounts. The dense white rock of the interior of the pillows consists of saussurite, of which zoisite forms the dominant mineral; plagioclase, quartz, and carbonate are present in smaller amounts. A possible explanation of this differentiation on a small scale may lie in the order of crystallization of minerals in igneous rocks, the ferromagnesian minerals normally preceding the feldspars. Since the outer portions of the pillows would cool first, the ferromagnesian minerals would consequently form there first by fractional crystallization and would concentrate in these border zones, leaving the remaining feldspathic portion to form the interior of the masses.

Iron Formation.

On the east shore of Tramping lake at the foot of a bay 2½ miles south of Wekusko falls a narrow band of lean iron formation is associated with the igneous complex. The width of the band as exposed by trenching is about 50 feet. Black, carbonaceous argillite occurs with the iron formation. These rocks contain arsenopyrite and pyrite in small veins and masses

Massive Acid Volcanics.

General. Part of the volcanic complex is composed of light coloured, acid rocks that are in places massive and in places sheared into sericite schists. They vary in composition from rhyolite to dacite, and some are distinctly porphyritic. They are intimately associated with the more basic rocks and only the most detailed work would suffice to separate the various flows. In places they cut the greenstone flows, but they are in turn traversed by lamprophyre dykes and the whole are so intimately associated that they are mapped together with the exception of one area of dominantly acid rocks important because it contains the principal veins of the area.

Quartz-porphyry. A belt of quartz-porphyry of a rather distinctive type occurs along Goose bay, Wekusko lake. Dark grey in colour, with round phenocrysts of vitreous and opalescent quartz varying up to one-quarter of an inch in diameter, it is a very hard and massive rock that appears to be a dyke cutting greenstone.

In thin section it is seen to consist of phenocrysts of quartz, orthoclase, and acid plagioclase in an altered microcrystalline groundmass of feldspar and quartz. The quartz phenocrysts are the largest and most numerous; some of them are broken and all show undulatory extinction. Their outlines are rounded, in places showing corroded embayments. The larger phenocrysts contain inclusions typical of the rock and containing small quartz phenocrysts. The orthoclase phenocrysts have indistinct outlines, due to their alteration to a large extent into sericite. The plagioclase phenocrysts are more abundant and larger than those of orthoclase and apparently consist of albite. Some of them show zonal banding and like the orthoclase phenocrysts and the groundmass have been altered with the production of sericite and kaolin.

Rhyolite. Acid volcanic rocks of the composition of rhyolite occur along the east shore of Wekusko lake. The rock is hard and massive: on its weathered surface it is of a light grey or pinkish-grey colour, but on its freshly broken surface it is darker. Locally, small phenocrysts of quartz and feldspar can be detected in hand specimens. In some of the sections studied phenocrysts are abundant and in others are entirely absent. Where present, they are quartz and feldspar. The quartz phenocrysts have rounded and corroded borders and many of them are broken. The feldspars consist of orthoclase and andesine (70 per cent albite). The groundmass, consisting of fine-grained quartz and feldspar with a few flakes of biotite and muscovite and grains of iron oxide in some sections, has a microgranular texture. Where sheared there is a development of sericite and in places the rock grades into a sericite schist. The rhyolite on the Rex property has the relations of volcanic flows interbanded with clastic sediments.

A variety of a slightly different type shows a peculiar mottling due to the development of biotite. On a surface broken parallel to the plane of their development, the biotite areas show up as round black spots varying up to one-half an inch in diameter. On other sections the rock has a light,

pinkish-grey colour with short, narrow lines marking the biotite areas. In thin section the rock is seen to consist of a microcrystalline aggregate of quartz and feldspar. Brown biotite occurs concentrated in narrow bands oriented in one direction. Muscovite and calcite are both present as alteration products of feldspar.

Porphyry. Some of the rocks lying between Wekusko and Stuart lakes can best be described under the term porphyry. Varying from light to dark grey in colour and characterized by pink and white phenocrysts of feldspar, they all have been sheared and altered to a greater or less extent. The feldspar phenocrysts consist both of orthoclase and acid plagioclase. The groundmass has a fine texture and consists of feldspar and quartz, with muscovite, biotite, carbonate, magnetite, and pyrite, abundant in some sections.

Autoclastics, Pyroclastics, and Breccias.

Fragmental volcanic rocks of both acid and basic composition are found at several places in the area. Three miles west of Anderson lake a broad zone of fragmental greenstone contains large bombs that stand out distinctly on the glaciated surfaces of the exposures. The bombs, a lighter green than the dense greenstone rock forming the matrix, are for the most part amygdaloidal, the amygdules being small and closely packed together. There is no sharp boundary between the amygdaloidal bombs and the enclosing matrix, owing, probably, to the absorption of the borders of the bombs by the lava.

East of Wekusko lake the acid volcanic rocks exhibit brecciated structure. Plate III shows a flow breccia in rhyolite on the Moore claim about 15 chains from the shore of the lake. The rock, consisting of flattened oval fragments of light-coloured, massive rhyolite in a matrix of similar composition, has a structure suggestive of that of a flow breccia in which there was a hardening and breaking up of the lava while still flowing. The flattening of the fragments took place, probably, under the weight of the rock itself while still viscous; had it been a secondary feature developed by later compression, a much greater development of schist-making minerals would be shown.

Finely banded, grey rocks, probably tuffs, north of the cabin on the Engineer claim, are among the acid volcanics on the shore east of Wekusko lake. Dark banded rocks, also probably of tuffaceous origin, are found associated in a similar way with greenstone on the north arm of Woosey lake.

Schists.

The complex of volcanic rocks has been locally extensively altered and changed into schistose rocks of which the dominant mineral may be chlorite, hornblende, or mica.

Chlorite Schists. Chlorite schists are the common product of the alteration of greenstone rocks, and all gradations exist from massive chloritic types to fissile schists. The rocks, greyish green to dark green, consist of chlorite, carbonate, iron ore with zoisite, and quartz. The highly schistose types form zones due, apparently, to intense shearing. The more massive chloritic rocks have resulted, probably, from alteration in the more disturbed zones.

Hornblende Schists. Hornblende schists are the common products of the alteration of greenstone rocks along the borders of granite stocks and batholiths. They are generally black rocks made up of fine hornblende crystals whose cleavage planes give a characteristic glistening appearance to freshly broken surfaces; locally, coarse-grained varieties of a dark green to black colour are found which consist of crystals of hornblende varying up to half an inch in length.

In thin section the rocks are found to consist largely of green hornblende; brown mica and chlorite are sometimes found in considerable quantities. The amounts of feldspar and quartz differ to a great extent in different specimens. Iron ore is present in all the sections and tourmaline in a few. East of Dion (Whitefish) lake a variety of hornblende schist along a granite contact contains numerous red garnets.

Hornblende schists may originate from either sedimentary or igneous rocks, but that most of those occurring within the map-area are of igneous origin is decisively proved by field evidence. Massive greenstone rocks grade into glistening hornblende schists near a granite intrusion and ellipsoidal structure can be observed on the weathered surface of amphibolites. An example of this is found in the V-shaped area lying between Snow river and Wekusko lake where an amphibolite showing pillow structure is interbanded with sedimentary garnet gneiss.

Biotite Schist. A biotite schist, apparently derived from an igneous rock, occurs on the Kiski claim on the east shore of Wekusko lake. It is a black rock consisting of biotite and quartz with minor quantities of calcite, pyrite, and scattered crystals of tourmaline.

Sericite Schist. The sericite schist of the area is the common product of shearing of the acid volcanics. East of Wekusko lake all gradations exist from massive rhyolite to fissile sericitic schists. On the west shore of Anderson bay, about 2 miles northeast of the mouth of Bear creek, occurs a white fissile schist, the result apparently of the shearing of an acid porphyry dyke that cuts the greenstone. A similar white schist occurs on the west shore of Wekusko lake opposite the portage to Mile 82.

Dyke Rocks of the Complex.

Lamprophyre dykes traverse both the volcanic rocks and the associated sediments. Most of them are narrow, only rarely attaining a width of 40 feet, and more commonly varying from only 4 to 10 feet in width. In hand specimen they are massive rocks, dark grey to black, and for the most part fine-grained. In thin section the most prominent mineral is seen to be a light green hornblende, commonly carrying numerous inclusions of quartz and iron ore. Brown biotite is common and in some specimens is more abundant than the hornblende. Chlorite is present in varying amounts; iron ore and apatite are present as accessory minerals and a few crystals of tourmaline were observed in one section. The finer-grained portion of the rock consists of feldspar (orthoclase and plagioclase) and quartz in varying amounts. The proportions of feldspars

and ferromagnesian minerals vary to such an extent in the different specimens studied, and so much alteration has taken place that it is difficult to determine the original minerals and their relative proportions, and all have been, consequently, grouped under the general term lamprophyre. It is not possible to state the age of all these dykes but they are younger than most at least of the rocks of the pre-granite complex. On account of their altered character they are described with it.

WEKUSKO SERIES.

The Wekusko series consists of gneisses and mica schists most of which are believed to be of sedimentary origin. The paragneisses are finely-banded rocks locally showing distinct bedding and crossbedding and with conglomeratic horizons (Plate I). They vary from light grey to dark grey in colour. They consist of quartz, feldspar, biotite, and usually garnet. The mica schists vary considerably depending on the kind of secondary silicates developed in them: garnet, staurolite, and garnet-staurolite types are the common varieties and in one locality a cyanite-bearing schist is associated with the other types. Fiv distinct areas of these rocks occur in the Reed-Wekusko sheet.

The largest area covered by rocks of the Wekusko series surrounds Herblet lake. It has for its southern boundary Snow lake, Anderson lake, and the north arm of Wekusko lake; on the east it sends one branch along Osborne lake and Wuskatasko river to the northern boundary of the map-area, and on the west includes Squall and Echo lakes and the country to the north.

Lithological Character.

General. The area presents a great variety of rock types of which the more important will be briefly described.

Paragneiss. The dominant rock is a finely-banded, grey gneiss, frequently garnetiferous and consisting largely of quartz, feldspar, and mica. The most common variety of mica is a brown biotite, but in some of the lighter coloured varieties muscovite is abundant. The feldspar is dominantly orthoclase, with minor quantities of acid plagioclase, the commonest variety of the latter being andesine of about 30 per cent anorthite. Quartz is abundant, and its fresh, interlocking grains show the rock has suffered recrystallization. Apatite crystals for the most part with rounded outliers, iron oxide, and garnet occur as accessory minerals with a few rare crystals of tourmaline. Certain types along granite contacts, as for example along the west shore of Squall lake and the east shore of Anderson lake, contain hornblende as the dominant ferromagnesian mineral. In some sections it comprises at least 25 per cent of the rock. On the east side of Crowduck bay, the dominant rock type is a garnetiferous gneiss. The gneiss is a grey to rusty-weathering, banded rock consisting chiefly of quartz and biotite, but with an abundant local development of garnets. On the east shore at the north end of Crowduck bay

the garnets are especially abundant. A conglomerate horizon occurs in the gneiss near the east shore of the bay which shows the sedimentary origin of the series. An analysis[1] of the gneiss shows the following ratios.

SiO_2	63·84
Al_2O_3	20·34
Fe_2O_3	3·34
FeO	3·98
MgO	2·20
CaO	0·64
Na_2O	0·95
K_2O	2·42
H_2O+	1·05
TiO_2	0·80
Total	99·56

Analyst, M. F. Connor.

The distinctive features of sedimentary origin such as dominance of magnesia over lime, potash over soda, excess of alumina, and high silica are all present.

Staurolite Schist. The Wekusko series is represented by a black staurolite schist, observed in the following places :

Snow and Anderson lakes.
File lake, southwest shore.
Lake between File and Loonhead lakes, south shore.
Lake between Dion lake and Crowduck bay.
Area between Crowduck bay and Grass river.
Niblock Lake area.

Immediately east of the outlet of Anderson lake a ridge approximately 1,500 feet long and from 100 to 200 feet wide extends in a northeast direction. The ridge is bordered on the west by low, swampy land facing Anderson lake and on the east by a stretch of muskeg 150 feet wide to the east of which runs a ridge of red granite-gneiss. The ridge of schist is well exposed throughout; it has been heavily glaciated and shows big grooves and furrows, one of which is 8 feet in width and 6 feet in depth. Like the paragneiss many varieties are met with and all gradations from the garnet gneiss to micaceous schists containing abundant staurolite crystals are encountered. The commonest variety is a biotite schist containing both staurolite and garnet. Towards the northeast end of the ridge a garnetiferous mica schist is developed in which garnet rhombic dodecahedrons varying in size up to 2½ inches in diameter in places comprise most of the rock.

The series consists of staurolite, cyanite, and garnet schists striking north 35 degrees east and dipping at an angle of 70 degrees to the northwest away from the adjacent granite-gneiss. The dominant rock variety is a green chlorite schist containing crystals of cyanite, staurolite, and garnet. Certain bands show large fans of white and reddish cyanite standing up prominently on the weathered glaciated surface. Bands in which staurolite crystals are predominant are also common, the staurolite crystals reaching in places a length of 2½ inches. Two bands averaging 3 feet in width are of a light-coloured schist made up of quartz, muscovite biotite, and small crystals of staurolite.

[1]Geol. Surv., Can. Sum. Rept., 1916, p. 167.

The staurolite and cyanite crystals for the most part lie in rows which seem to represent original bedding planes. The bands are commonly wavy suggesting drag folding on a small scale in the beds, a feature which is emphasized in places by narrow crenulated bands of quartz.

Slabs of schist containing large staurolite crystals can be collected from small islands near the southern end of Crowduck bay, and near the mouth of the creek entering it from the southwest. Crystals up to 4 inches in length stand out prominently on the weathered schist surfaces. Many of them show the characteristic cross forms. In some places the schist contains numerous small staurolite crystals averaging half an inch in length, arranged in parallel rows which undoubtedly represent lines of original bedding.

In thin section the rock is seen to consist of quartz, biotite, and muscovite, with large garnet and staurolite crystals and a few tourmaline needles. The mica plates have a common orientation and many of the biotite crystals show pleochroic halos. The garnets have good rhombic dodecahedral outlines. They have developed across the schistosity, without deforming the adjacent minerals, the biotite flakes ending abruptly at their edges. The crystals of staurolite are apparently of later development. They include garnet crystals and in most cases deform the adjacent minerals. In places big flakes of muscovite and biotite bend around the sides of a staurolite crystal showing the pressure it has exerted in its growth.

Quartzite, Arkose, and Conglomerate. Certain of the fine-grained, well-bedded parts of the series consist dominantly of quartz and may be described as quartzites. All, however, contain more or less feldspar and biotite and grade into sedimentary gneisses; beds of conglomerate are also locally found. Crossbedding is well shown in many places (Plate IIB). One type consists of a single bed of diagonal layers bounded on either side by parallel beds marking the strike of the formation. The more common variety, however, is very irregular, with curved diagonal layers, and in places is suggestive of wind deposition. Conglomerate horizons are found at various places east of Stuart lake. The ridge separating Burns and Softwater lakes consists of conglomerate, and northeast of Stuart lake are several ridges also composed of conglomerate. The conglomerates stand vertically and are composed of well-rounded boulders of porphyry, granite, and basic volcanic rocks.

North of Niblock lake is a highly schistose conglomerate containing rounded boulders of porphyry, greenstone, quartz, and granite.

Summary Regarding the Wekusko Series.

The chief points concerning the relations of the Wekusko series are as follows:

(1) In several localities sedimentary rocks are found interbanded with volcanic rocks, both acid and basic.

(2) The sedimentary rocks nearly everywhere stand vertically or at high angles. Low dips are the exception.

(3) The strike of the sediments is the same as the foliation of adjacent volcanic rocks.

(4) The sediments have conglomeratic horizons. No evidence was found that there might be infolded members.

(5) The series has been metamorphosed with the development of mica, hornblende, and later garnet, staurolite, and cyanite.

(6) At the eastern edge of the area, sedimentary gneiss was found dipping under schistose basic volcanic rocks.

(7) North of Niblock lake, conglomeratic staurolite schist overlies greenstone.

(8) In spite of the metamorphism which the series has undergone, lines of bedding and crossbedding have not been entirely obliterated in the series.

(9) Granite, pegmatite, and lamprophyre dykes cut all the members of the series.

(10) The sedimentary divisions show great thicknesses, great variation in degree of coarseness, and local conglomeratic horizons.

(11) There is a total absence of limestone, only a small development of slate, and a great predominance of clastic sediments.

The pre-granitic complex is interpreted, therefore, as representing a series of interbanded sediments and volcanic rocks of varying composition. Though the sedimentary division contains members which have pebbles of granite, quartz, and volcanic rocks, no evidence was found that these pebbles were derived from any rocks now exposed in the area, nor was any evidence found, aside from the presence of these boulders and pebbles, which would suggest that the members containing these fragments represent a younger series infolded with the complex and separated from it by an erosional unconformity. The whole group is regarded as a series of flows and contemporaneous sediments. The absence of limestone, the dominance of clastic sediments, the irregularity of the beds, the great thicknesses locally, the recurrence of conglomeratic horizons, point to a continental rather than to a marine origin for the series.

GRANITE AND GRANITE-GNEISS.

Distribution.

Approximately 50 per cent of the Reed-Wekusko Lakes map-area has granite and granite-gneiss or associated types as the surface rock. To the north and east of the area these rocks are widespread, having been intruded as huge batholiths which are now laid bare by erosion. The intrusions in the area, however, are for the most part isolated stocks, though united probably at no great depth. Most of the stocks are oval in section, elongated in a northeast direction. As a rule the interstream areas consist of granite with frequently only a narrow border of older rocks fringing the river valleys and lakes.

Lithological Character.

Massive granite is more characteristic of the area than the well-banded gneisses. In colour, reddish and light grey are the prevailing varieties, although dark grey types are found locally, especially along the borders of intrusions. In texture all gradations from coarse to fine-grained exist and porphyritic varieties [illegible] form border phases. The composition varies from acid granite to diorite; aplite, pegmatite, and lamprophyre dykes, late differentiates of the granite magma, are numerous.

A brief description of the chief varieties occurring in the area is given below:

Biotite-granite. Biotite-granite is the most common variety met with in the region. A good example is the mass lying southeast of Bear creek. It is a red, coarse-grained, massive rock forming an oval area whose borders stand up in places 30 feet above the surrounding greenstone. A thin section of a similar rock collected west of Goose bay shows the following minerals: microcline, orthoclase and plagioclase feldspars, quartz, biotite, and a little iron oxide. The biotite is brown in colour and is not abundant. Most of the quartz particles show undulatory extinction. Of the two potash feldspars, microcline is the more abundant, the plagioclase is oligoclase; some of the crystals show good zonal structure.

A finer-grained variety is found south of Softwater lake. The rock is massive and varies in colour from red to dark grey. In thin section the biotite crystals are seen to be small, of a deep brown colour, and are evenly distributed throughout the section. Quartz is abundant, occurring as small, fresh grains. The dominant feldspar is orthoclase with microcline and albite in minor amounts. Apatite, iron oxide, and titanite occur as accessory minerals.

Hornblende-biotite-granite. Towards the eastern edge of the sheet the granite is red and fine-grained and locally is gneissoid. A section from a specimen collected on Dion (Whitefish) river shows the rock to be a hornblende-biotite-granite. The biotite is of the deep brown variety; the hornblende is highly pleochroic; X = light yellow, Y = light green, Z = dark green, absorption $Y > Z > X$. Quartz is abundant as coarse grains most of which show undulatory extinction. The feldspars include orthoclase, plagioclase, and microcline. The last is the least abundant of the three and orthoclase is less abundant than plagioclase. The plagioclase is an oligoclase andesine, an average of a number of determinations showing a composition corresponding to 28 per cent anorthite. Many of the crystals show pericline twinning in combination with albite and Carlsbad twins. Apatite is present as an accessory minera and a number of large grains of iron ore are present. A section of a pink granite north of Dion lake shows similar characteristics. Biotite in this is, however, the more important ferromagnesian mineral, hornblende occurring only as small scattered crystals.

Quartz-monzonite. South of Goose bay is an area of granite which outcrops on the southwest shore of Wekusko lake. The marginal phase of this intrusive mass is dark grey to black in colour, but a short distance from the shore it grades into normal red granite. A thin section from a specimen collected near the shore of the lake shows the following minerals to be present: quartz, orthoclase, plagioclase, biotite, hornblende, chlorite, rutile, titanite, iron ore, apatite, and tourmaline. The plagioclase is present in practically the same amounts as the orthoclase; its composition is that of andesine containing 35 per cent anorthite. Of the ferromagnesian minerals, biotite has crystallized first. It is dark brown in colour and is altered in places to chlorite and in others to rutile and iron ore. The hornblende is highly pleochroic, varying from light yellow to dark green. Apatite is abundant as an accessory mineral; several grains of tourmaline, pleochroic in shades from light to dark bluish-green, are found in the sections.

Quartz-diorite. Along the east shore of Herb bay the border of another stock consists of a similar but slightly more basic rock. It is a massive, dark grey to black rock and fairly coarse-grained. Approximately 35 per cent of it consists of green hornblende altering to chlorite; a little brown biotite is present. Quartz is present in considerable quantities. Of the feldspars, plagioclase is more abundant than orthoclase. Optical determination of a number of suitably oriented sections shows that the former is an andesine with a composition corresponding to 33 per cent anorthite. Iron ore and apatite are present as accessory minerals.

Porphyritic Quartz-diorite. Along the west shore of the narrows south of Crowduck bay the border phase of the intrusive is a porphyritic quartz-diorite. The phenocrysts are numerous and many of them are over 2 inches in length. They consist of andesine. The matrix is dark coloured and in thin section resembles the quartz-diorite already described.

Pegmatite. Pegmatite dykes are common, particularly along the borders of granite intrusions. They are found cutting both the granite and the older complex. Some of the larger dykes are coarse-grained with crystals of feldspar a foot in length. The dominant mineral is orthoclase, the next most abundant mineral is quartz; muscovite is usually present; black tourmaline is abundant in some of the dykes. In the northeastern corner of the area a single large dyke of white graphic pegmatite was found.

Lamprophyres. Dark coloured dykes are found locally traversing the granite and all the older rocks. They are uniformly narrow, few exceeding a width of 4 feet. Some of them may be traced for a length of several hundred feet. The rock is dense, and frequently black in colour. Under the microscope the chief mineral present is seen to be a brown biotite which has been largely altered to a light greenish chlorite. Green hornblende is also present in some sections. Iron ore is present in considerable amounts. Quartz is present in varying quantities. The feldspars occur as small grains and never as phenocrysts.

Structural Relations.

Though the granites and granite-gneisses present considerable variation in appearance, texture, and composition, there is no decisive evidence that they are not all to be referred to the same general period of intrusion. Wherever relations were definitely established they were found to be intrusive into the other Precambrian rocks of the region. That an older granite did exist is shown by the presence of granite boulders in conglomerates which are traversed by younger granite, but it was not found possible to locate any of these older granites definitely in the field.

The contacts of the granite stocks with the intruded rocks are of two varieties. An example of the first type is found in the peninsula between Tramping lake (Plate IIA) and Goose bay on Wekusko lake. Here the contact consists of a zone in which large angular blocks of greenstone are found surrounded by granite. In places the blocks are entirely separated from each other, in places they are traversed by a network of narrow dykes. At most places where the actual contact of the granite and the continuous greenstone mass was observed, it was found to dip under the greenstone in places at low angles, which renders it probable that the granite bodies are united at no great depth. The border zone containing zenoliths is of varying width; in places it is only a few hundred feet wide; around Highway lake, however, there is a zone over a mile in width consisting of approximately half granite and half greenstone. Where the zenoliths are numerous there seems to have been but little assimilation, for the contacts between the stoped blocks and the red granite are sharp with no apparent difference in the granite at the contact and away from it.

The second variety of contact is that in which there is a basic border to the intrusive mass. One of the best examples of this type is to be found in the peninsula east of Herb bay, where a granite mass is fringed by a narrow border of greenstone schist and staurolite schist. In places it is difficult to determine the exact line of contact between the dark border of the intrusive and the intruded greenstone, although a few feet from the contact there is never any doubt. The border phase of the intrusive as already described is a quartz-diorite containing abundant hornblende; towards the centre of the mass, however, it becomes the typical red biotite granite. The gradation in composition and the absence of stoping effects is evidence for marginal assimilation by the granite. In this type the schistosity of the intruded rock swings around the stock parallel to the contact.

Method of Intrusion.

The granites are intruded as stocks and batholiths. The wide extent of the latter and the great number of the former with their sloping surfaces suggest that they are all united in depth. In the mechanics of intrusion, stoping has played an important part. Evidence of this may be found in the presence of zenoliths along the border zones; in places a network of dykes in the greenstone border shows how the process progressed.

That assimilation was also a factor is shown by the presence of zones of hybrid rocks along the borders of some of the stocks. It is probable, however, that this was only of minor importance. The fact that the schistosity of the rocks surrounding this type of stock follows the contact suggests that these stocks were intruded under pressure.

In places a well-banded structure has been produced in some of the older sedimentary series by the injection of granitic bands along structural planes. An example of this lit par lit injection is well displayed north of Dion lake where pegmatitic bands are interlayered with bands of garnetiferous mica gneiss.

Causes of Lithological Variation.

The causes producing the diversity of lithological character are three in number: (1) differences due to separate intrusions; (2) differences produced by differentiation; (3) differences produced by assimilation.

Although many of the intrusions show slightly different types both in regard to texture and structure and also as to mineralogical composition, such differences do not necessarily imply an age difference.

Differentiation is shown by the presence of aplite and pegmatite dykes on the one hand and of lamprophyres on the other. This differentiation into complementary types was a process of only minor importance and was confined to the late stages of cooling.

The more basic border zones of certain stocks already referred to may be explained as a result of either differentiation or assimilation or perhaps to a combination of these two processes. As already stated the dark borders of these stocks differ from the normal granite, chiefly in the higher percentage of ferromagnesian minerals and more especially of hornblende. Since in the crystallization of a magma the ferromagnesian minerals normally form earlier than the feldspathic, the basic border zones might be explained by the operation of convection and crystallization. On the other hand the fact that the more basic borders of the stocks are confined to places where the intruded rock is basic in composition is strong evidence for the supposition that assimilation has been a factor.

ORDOVICIAN.

Ordovician limestone underlies the southern portion of the area. Its northern boundary is an escarpment varying in height up to 80 feet. Immediately north of the escarpment most of the country is low. The escarpment is very irregular in outline, with many re-entrant bays and narrow arms fingering out into the muskeg to the north. The higher cliffs are those that run in a northeast direction parallel to the direction of glaciation. At other places the escarpment rises in a series of steps to the top of the formation. A number of outliers were found north of the main escarpment.

The series is undisturbed and lies horizontally on eroded granite and steeply inclined schists. At the southern end of Wekusko lake greenstone cliffs rise to a height of 30 feet above the base of the limestone, showing the irregular character of the floor upon which the series was deposited. No evidence was found of a clastic basal member.

The limestone is for the most part thick-bedded. In colour it is yellowish to dirty grey; some of the lower beds on Wekusko lake are reddish and mottled and weather almost black. In composition it is magnesium-bearing, in places at least approaching a true dolomite. Fossils are not abundant. From Wekusko lake the following were collected in 1896 by J. B. Tyrrell and identified by Whiteaves who referred them to the Trenton: *Receptaculites oweni*, Crinoid stems, *Columnaria alveolata*, *Palæophyllum rugosum*, *Calapoecia canadensis*, *Stictopora acuta*, *Orthis testudinaria*, *Maclurea* (*Maclurina*) *manitobensis*, *Tripteroceras lambii*.

The following were collected by the writer in 1917 and were identified by L. D. Burling: *Halysites catenularia gracilis* Hall, *Streptelasma robustum* (?), Crinoid stems, Bryozoan, undetermined fragments, *Strophomena* sp., *Plectambonites sericeus* (Sowerby,) *Platystrophia* sp., *Rhynchotrema* sp., *Maclurea* (*Maclurina*) *manitobensis* Whiteaves, gastropods, 2 undetermined fragments.

Concerning the above collection Mr. Burling has written the following report: "Of the species collected by Mr. Tyrrell two (*Palæophyllum rugosum* and *Stictopora acuta*) have not been identified from the sections near lake Winnipeg where the stratigraphy has been worked out in detail.[1] With the exception of two others (*Orthis testudinaria* and *Tripteroceras lambii*) the remainder have been identified from both the Lower Mottled limestone and the Upper Mottled limestone, formations which, with the intervening Cat Head limestone, have been referred to the Trenton. Since all of the species collected by Alcock have previously been identified from both of these formations, we are warranted in identifying this collection as Trenton, and our problem resolves itself into one of determining, if possible, the formation from which the fossils were secured."

"The exposure south of Wekusko lake is in the form of a cliff of flat-lying sediments overlooking a marshy flat containing occasional outcrops of Archæan, some in immediate proximity to the fossil-bearing strata. Farther to the south the basal portion of these sediments is composed of shales and sandstones, approximately 100 feet thick, to which the name 'Winnipeg s[illegible]tones' has been applied. Dowling[2] has already called attention t[illegible]t that to the east and north of Dog head (or the west shore of lak[illegible]eg) this basal sandstone is absent, and that the limestones must h[illegible]been deposited immediately on the Archæan. The fossils secured near Wekusko lake appear, from the slight evidence we have, to bear closer relationships with the Upper Mottled than the Lower Mottled limestones, and this conclusion is supported by the lithology of the beds. If this interpretation be true, the apparent overlying action which has cut out the Winnipeg sandstones northwest of Dog head continues in the direction of Wekusko lake, and has there resulted in the further disappearance of the Lower Mottled limestone (70 feet) and the Cat Head limestone (70 feet). That this condition is due in part, at least, to a thinning of the formation as we proceed northward, is indicated by the much increased thicknesses

[1]Dowling, D. B., "Report of the geology of the west shore and islands of lake Winnipeg" Geol. Surv., Can., Ann. Rept., vol. XI, pt. F, 1900.
[2]Op. cit.

obtained in well records near West Selkirk, 100 miles to the southeast, but it appears probable that this is accompanied by an overlapping of the successive shore-lines upon the Archæan regolith. This progressive northward overlap of successively higher units of the Palæozoic upon the Archæan is of considerable interest and worthy of further study."

"To sum up, the limestones outcropping immediately to the south of Wekusko lake are referable to the Trenton group of the Ordovician and probably belong with the Upper Mottled limestone division of that group in the Manitoba region."

PLEISTOCENE AND RECENT.

Glacial.

As already stated in chapter II the country shows evidence of having been overrun by ice-sheets, mainly from the northeast. The deposits left by the glaciers are not extensive. They consist of scattered erratics and accumulations of drift in depressions and on the lee slopes of southward-facing cliffs. Local sand-plains represent outwash deposits of fluvioglacial origin. One of the most prominent in the area is crossed by the portage connecting Reed and Morton lakes.

Post-Glacial.

Stratified lake clays overlie the boulder clay deposits of the region. In the western portion of the area these lacustrine deposits occur as small isolated areas, but in the eastern part they are thicker and more continuous. They represent deposits made in glacial Lake Agassiz which extended southward from the retreating front of the ice-sheet. The streams from the ice-sheet being heavily charged with suspended sediment, rapidly formed widespread clay deposits in the lake basins.

CHAPTER V.

ECONOMIC GEOLOGY.

GOLD.

HISTORY.

The only important ore deposits which have yet been found in the Reed-Wekusko Lake area are gold-bearing quartz veins along the east shore of Wekusko lake. The presence of quartz veins was first mentioned by J. B. Tyrrell in a report on the northeastern portion of the districts of Saskatchewan and Keewatin (1900). The discovery of gold in quartz on Amisk or Beaver lake in the summer of 1913 created a new interest in the areas of basic Precambrian rocks north of Saskatchewan river, and

two prospectors, Messrs. Hackett and Woosey, after reading Mr. Tyrrell's report, decided to prospect along Wekusko lake. They entered the area in the summer of 1914 and found gold-bearing quartz on the east shore of the lake on what is now known as the Kiski claim. After doing sufficient stripping and trenching to satisfy themselves as to the size of the vein they returned to The Pas and recorded their claims. The report of their discovery induced other prospectors to enter the region and a number of veins were found close to the original discovery. Since that time a considerable amount of prospecting has been done each summer and many claims have been staked. In the winter of 1916 the discovery of gold on Herblet lake led to the staking of a large number of claims along the shores of its northern arm, but on only one of these has any development work been performed. Most of the prospecting throughout the entire map-area has been confined to the shores of the lakes along the canoe route and to the immediate vicinity of Grass river. The whole region has been traversed many times in this hurried manner, but in only a few places has any detailed examination been made.

A considerable amount of development work has been done on a number of properties. A mill was installed on the Rex group which began crushing in the spring of 1918. Owing to a number of adverse conditions, however, such as the scarcity of labour and the high cost of transportation, operations were not profitable and in December work was suspended. The only other property which has shown actual returns in gold is the Northern Manitoba group.

GEOLOGY.

The geology of the region has already been described and a detailed description of the rock types given, but for the convenience of those more particularly interested in the ore deposits, a few of the main facts will be repeated here. The rocks belong to two geological eras, the greater part of the area being underlain by rocks of Precambrian age, but with a belt of Palæozoic dolomite extending across the southern margin of the sheet. Since, however, the ores were all deposited before the formation of the Palæozoic rocks, the latter are of no interest in this connexion. The Precambrian rocks consist of a complex of igneous and sedimentary rocks intruded by granite and granite-gneiss. The igneous members of the complex are largely of volcanic origin representing flows, tuffs, and breccias, although some of the more massive varieties seem to be altered intrusive rocks, largely diorites. In composition the volcanics vary from acid to basic rhyolites, quartz-porphyries, andesites, and basalts. In texture, they grade from hard, massive types to schistose rocks; the acid varieties alter to sericite schists, the basic to chlorite and hornblende schists. The sedimentary rocks consist of quartzite with conglomeratic bands, garnet-gneisses, and staurolite schists. They are interbanded with at least part of the volcanic rocks and the whole is considered to be a thick series of interbedded flows and clastic beds. Intrusive into this complex are stocks and batholiths of granite and granite-gneiss. A great erosional unconformity separates all these rocks from the overlying Ordovician dolomite in the southern part of the area. In the eastern part much of the bedrock is covered by post-glacial Lake Agassiz clays which, with large areas of muskeg, make prospecting difficult.

ORE DEPOSITS.

The gold-bearing quartz veins traverse all the Precambrian rocks of the area, and all the evidence points to their genetic relationship to the granite intrusions. The granite is the youngest intrusive of the region cutting all the other Precambrian rocks; since quartz veins are found in the granite as well as in the older rocks, they have probably been derived from it. Many of the quartz veins along Grass river contain considerable quantities of orthoclase, in fact all gradations exist between true quartz veins and true pegmatites; and as the latter were undoubtedly derived from the granite it must be assumed that the auriferous veins had a similar origin. Tourmaline, a common pneumatolytic product of granitic intrusions, is abundant in many of the veins. Arsenopyrite is present in all the gold-bearing veins and is locally found disseminated in the granite as an apparently original constituent. The main veins of the area are situated along the border of a granite stock lying between Herb bay and Grass river; the stock has produced extensive metamorphic effects with the development of garnet and staurolite-bearing schists along its borders and has without doubt also been responsible for the formation of the veins.

It is evident, therefore, that gold-bearing veins may be found in any of the Precambrian rocks of the area and the best localities for search are the areas along the borders of granite intrusions. The more important discoveries have been in the acid volcanic rocks, probably because the hard, massive rhyolite is more favourable for the preservation of fissures than are the softer and more schistose rocks.

Most of the veins of the area are lenticular. Many of them follow the structure, either bedding or schistosity, and small stringers are usually parallel. The Kiski property shows the same tendency among the larger veins; on this claim No. 1 and No. 2 veins are both large and well defined and have only 5 degrees difference in their strike.

The quartz of the veins varies considerably. Many of the barren veins consist of white quartz with no sign whatever of mineralization or even iron stain. In the gold-bearing veins the quartz is white to brownish in colour; in texture it varies from fine granular to coarse vitreous. The variety that usually carries the highest values is a fine, granular type traversed by dark streaks. Most of these streaks are short and very irregular, and along them are usually concentrated sulphides, tourmaline, and most of the gold. Needles of tourmaline, specks of sulphides, and visible specks of gold, however, are found in places in the quartz away from any of these dark patches. Arsenopyrite is by far the most abundant sulphide in the quartz, but pyrite, chalcopyrite, galena, and sphalerite also occur. Feldspar crystals are occasionally found.

Most of the deposits represent fissure veins, being linear, more or less lenticular bodies with sharply defined walls. Along some of the veins, however, the country rock has been extensively altered, giving rise to a border zone consisting of sulphides and carbonate rock. The gold values are in places concentrated in this zone.

The presence of tourmaline in practically all the veins is evidence that they are high temperature deposits. Where gold is present in visible quantities it is commonly associated with the tourmaline and in places is completely surrounded by it, and must, therefore, have been deposited at high temperature.

SUMMARY REGARDING GOLD-BEARING VEINS.

The gold-bearing veins are the youngest Precambrian deposits of the region and are found traversing all the consolidated rocks with the exception of the Ordovician dolomite. They are believed to be high temperature deposits genetically related to the granitic intrusions. These intrusions were accompanied by deformation which produced fractures, shear planes, anticlinal openings, and other lines of weakness. As the granite mass cooled and began to solidify, the volatile constituents became more and more concentrated in the remaining portion of the magma and finally, in the later stages of the intrusion, were given off, forming pegmatite dykes and quartz veins. Fractures would naturally be more abundant in the roof of the batholith and it would be along these that the ascending solutions would escape. The veins would, therefore, be most numerous along the upper portion of the intrusion. In pre-Ordovician time the region suffered long-continued erosion and denudation progressed so far that over most of the region the roofs of the batholiths were stripped off and much of the granite itself removed. In such places the ore deposits likewise were destroyed. In other places where the intrusions did not come so near the surface, erosion has uncovered only the irregular upper parts of batholiths. These consequently are much more favourable places for prospecting than where wide areas of granite are now exposed.

Though the border zone of small intrusions representing the upper parts of batholiths are thus the most probable places in which veins will be found, search should not be confined to the immediate vicinity of the contact of a granite stock with the surrounding intruded rock. Areas of pre-granitic complex may be underlain at no great depth by intrusive masses. Solutions also may travel considerable distances from their parent magma. The Rex vein lies at a distance of over a mile from the nearest granite exposure and the Kiski veins at a distance of nearly 3 miles. The Twin Lakes property shows that even in the borders of the stock itself deposits of ore may be found.

DESCRIPTION OF PROPERTIES.

The following is a brief description of the more important properties of the area visited during the summers of 1917 and 1918 and summarizes the information at the latter date.

Rex Group.

The Herb Lake Gold Mines Company, Limited, controls a group of seven claims on the east shore of Wekusko lake, on which is located a vein generally known as the Rex. The company was promoted by the Makeever Brothers, brokers of New York, and was incorporated in Manitoba in

1918 with a capitalization of $1,000,000, divided into dollar shares. A total of $38,000 has been spent on developing work on the property. The equipment, valued at $104,590, consists of a mill with a capacity of 30 tons a day, a 55-horsepower Atlas engine, 60-horsepower Vulcan boiler, 2 Deister concentrating tables, 1 grizzly, 1 Dodge breaker, a 5-foot by 6-foot hoist, and the necessary complement of drills and other essential tools. Up to the end of November, 1918, the production in gold, not including concentrates, was in excess of $27,000. The shaft is 127 feet deep, and drifts have been run at the 100-foot level 250 feet south and 90 feet north.

The accompanying map (No. 1763) of the Rex group of claims shows the geology of the immediate vicinity of the vein. It may be described in brief as an interbanded series of sediments and acid volcanics intruded by lamprophyre dykes. The vein lies in rhyolite near its western contact with a quartzite band, and follows closely the strike of the formation.

The sediments consist of a band of slate along the shore and two horizons of arkose. The arkose stands on edge or with steep dips to the east and the upper part of the beds is towards the east. Conglomeratic bands are numerous in the arkose but do not form definite continuous horizons. The pebbles consist of quartz, volcanic rocks of both light and dark colours, porphyry, and more rarely granite. Locally, masses of breccia composed largely of angular fragments of rhyolite are associated with water-sorted fine material. In places, bedding and crossbedding are well shown on weathered surfaces.

In hand specimens the arkose is a grey, fine-grained rock, hard and fairly massive. In thin section it is seen to consist largely of quartz and biotite. Muscovite is present in varying amounts. Orthoclase, albite, and graphic intergrowths of quartz and orthoclase are also present. The quartz crystals show an interlocking arrangement throughout, pointing to a recrystallization of the rock. Garnets are abundant locally and in places the rock resembles somewhat the typical garnet gneiss of the region.

The volcanic bands consist of a dense, hard rock which weathers to a light pinkish-grey colour; freshly-broken surfaces, however, are usually much darker. Small phenocrysts of feldspar and quartz can be observed in most hand specimens. Along the hanging-wall of the vein the rock is dark in colour and slightly schistose. In thin sections phenocrysts are locally abundant and in others are absent altogether. When present, they consist of quartz and feldspar, including both orthoclase and plagioclase. The latter in one section consisted largely of andesine with an average of 70 per cent albite. The quartz phenocrysts have rounded and corroded borders and nearly all are broken and exhibit undulatory extinction. The groundmass is holocrystalline with a microgranular texture, consisting of a fine-grained mixture of quartz and feldspar. Small flakes of both biotite and muscovite are numerous in some sections, the biotite being the more abundant. In specimens which have been more or less sheared considerable quantities of fine sericite occur concentrated to a large extent in narrow bands. Iron ore, carbonate, and chlorite, are present in varying amounts in the sections.

One hundred feet east of the shaft-house is a band of dark rock 40 feet wide which cuts across an horizon of rhyolite and then follows its contact with a quartzite band to the west. The rock is dark grey in colour, is dense and massive, and locally contains small red garnets. Since in its field relations it is a long, narrow band with approximately parallel sides cutting across a rhyolite band, it is classed as a dyke rock. In thin section the most prominent mineral is brown biotite, which is present in both large masses and small flakes. Most of the flakes have a common orientation but some of the larger masses lie directly across this direction. Part of the biotite has altered into chlorite. Iron and apatite are present and a few long crystals of tourmaline. Carbonate is abundant. The finer-grained portion consists of feldspar with subordinate amounts of quartz. The feldspar is unstriated, but optical determination of some of the particles showed that much at least of it is plagioclase of composition approximately 85 per cent albite. The rock is accordingly classed as an acid kersantite.

Another variety of lamprophyre intrudes the rhyolite and forms sills and dykes in the quartzite. In hand specimen the rock is dense and massive and of a dark greenish-grey colour. In thin section much the most prominent mineral is a light green hornblende for the most part containing numerous inclusions of quartz and iron. In some sections the hornblende has a radiating structure. Brown biotite is common in most of the sections studied. The remainder of the rock consists of orthoclase, a little plagioclase, and a considerable amount of quartz. From its mineralogical character the rock is classed as vogesite. It forms a number of dykes on the property and three narrow sills 300 feet north of the mill.

The vein lies approximately 200 feet from the shore of Wekusko lake and runs practically parallel to it in a direction 20 degrees east of north, following closely the contact between rhyolite and arkose. The vein, which dips at an angle of 65 degrees to the east, has been traced for a distance of 1,700 feet and has been uncovered for a distance of 1,300 feet. It maintains a width of from 2 to 5 feet for most of its length, but in two places it swells to widths of over 15 feet, and at others it pinches to less than one foot. Rhyolite is the wall rock for the greater part of the vein but, in places, one wall is arkose. Shearing of the rhyolite has developed biotite, and locally the rock along the vein is darker than the typical variety.

The quartz of the vein is a granular, white to brownish white in colour. In places, gold visible to the naked eye. Sulphides are present in small amounts. As far as development work has progressed the values persist with depth; as far as the boundaries of the ore-shoots have been determined by sampling they seem to be practically vertical. If this should prove to be a rule the estimation of values would be comparatively simple.

Northern Manitoba Group.

The Northern Manitoba Mining and Development Company of The Pas owns the Moosehorn and Ballast claim, consisting of 90 acres situated on the east shore of Wekusko lake 1½ miles south of the Rex. A shaft has been sunk to a depth of 100 feet and about 50 feet of drifting

has been done at this level. One car-load of ore amounting to 57,000 pounds was shipped to Trail, British Columbia, the returns from which amounted to $2,323, an average of $81.53 per ton in gold.

The rocks of the claims consist of lavas intruded by lamprophyre dykes. The former commonly weather to a light colour, are locally porphyritic with pink feldspar phenocrysts, are all sheared to some extent, and locally have been altered into sericite schists. Along the shore there are some pyroclastic bands. A section of the rock at the canoe-landing shows phenocrysts of quartz and orthoclase in a microgranular groundmass consisting of quartz, feldspar, and carbonate. Brown biotite, muscovite, and chlorite are scattered sparingly throughout the section, and fine sericite is abundantly developed. Cutting these rocks are dykes and masses of a dark lamprophyre rock, which in thin section is seen to be highly altered, consisting of brown biotite, largely altered into chlorite, small amounts of muscovite, feldspar largely changed into carbonate and sericite, a little iron ore and apatite, and quartz. The vein lies in the largest of these lamprophyre dykes.

The vein as traced by trenching, has a length of about 250 feet. The average width of the vein where uncovered is about 18 inches. The vein-filling is granular quartz with much tourmaline in places and small amounts of metallic minerals, gold, arsenopyrite, pyrite, chalcopyrite, galena, and sphalerite. In one specimen a telluride determined by R. A. A. Johnston to be probably petzite, was found surrounding some of the gold particles. Besides the main vein there are on the property other exposures of quartz that require further exploration.

Kiski-Wekusko Claims.

The Kiski-Wekusko, the first discovery of the area, is situated one mile south of the Moosehorn and Ballast. Three main veins are exposed. No. 1 (Plate IV) has been stripped for over 700 feet and has an average width of [illegible] feet, at one point swelling to a width of 12 feet. It strikes 30 degrees east of north following the foliation of the country rock and has a steep dip to the east. The wall rock is a biotite schist containing a considerable amount of calcite. Arsenopyrite and tourmaline also occur as impregnations. No. 2 vein has a width varying up to 12 feet and an average of about 3 feet. It has been stripped for over 500 feet and traced much farther. A shaft has been sunk to a depth of 53 feet on this vein. The wall rock is abundantly impregnated with arsenopyrite, both granular and well crystallized. No. 3 vein is not as regular as the other two. It is narrow, has been traced for about 100 feet, and contains gold in visible quantities. Still another vein on the property has been traced for 400 feet. Other exposures of quartz also occur.

McCafferty Claim.

The McCafferty vein lies 1½ miles east of the narrows south of Crowduck bay. It has been traced by stripping and trenching for over 1,600 feet. The vein which lies in an acid volcanic rock strikes 25 degrees east of north. The width varies to over 8 feet. The vein-filling is quartz with small amounts of sulphides. Tourmaline occurs and in one specimen brown crystals of this mineral are abundant. At the shaft the vein is divided by a horse of rock impregnated with arsenopyrite.

Elizabeth-Dauphin Claims.

The Elizabeth and Dauphin claims form part of a group of four properties belonging to The Pas Consolidated Mines, a company with headquarters at Winnipeg. The group lies 1½ miles northeast of the Rex on a line between the Rex and the McCafferty. The vein has an exposed length of 800 feet and a width varying up to 5 feet with an average of about 2½ feet. It strikes 40 degrees east of north, has vertical walls, and is well defined. At its north end it breaks up into a series of small stringers. The country rock is rhyolite interbanded with conglomerate and cut by lamprophyre dykes. The relations and rock types are similar in many ways to those displayed on the Rex group. The quartz of the vein is white and granular. Small amounts of arsenopyrite, pyrite, and chalcopyrite are present.

Syndicate Claim.

The Syndicate is situated on the south shore of the peninsula northwest of Campbell island. The vein lies in greenstone schist near the contact with the granite intrusive. Both the foliation of the schist and the vein itself are parallel to the contact. The vein averages less than 2 feet in width. It contains gold in visible quantities. Besides the Syndicate a number of other claims have been staked along the same granite-schist contact.

Apex Group.

A number of claims were staked in the spring of 1918 about 2 miles northwest of the Syndicate. The discovery is a mineralized zone in massive red granite. The rock that carries the ore is much like the regional granite but is lighter in colour and may best be described as a fine-grained pegmatite. It is more quartzose than the granite and grades by loss of feldspar into typical quartz vein material. The contact between the pegmatite and the regional granite is locally distinct, but in places it is difficult to distinguish the two types. In such places the lode is recognized by the presence of sulphides of which arsenopyrite is the most abundant. The mineral zone is irregular; at one place it has a width of 40 feet. In places the granite is shattered and small quartz stringers form a stockwork. The mineralized area is large and in places the rock carries high gold values, but careful sampling is necessary to determine its average value.

Island Claims.

A number of claims have been staked on the north arm of Herblet lake, but on only one of them, the Island, situated about halfway up on the west shore, has any development work been done. A number of quartz exposures are found on this claim and at the bottom of a shallow pit sunk on one of them several quartz stringers unite to form a vein 2 feet 8 inches wide. In addition, a zone of sulphides 36 inches wide along the foot-wall and a band of carbonate rock 14 inches thick along the hanging-wall carry low gold values.

MOLYBDENITE.

Molybdenite occurs in small quantities in a number of veins and pegmatite dykes throughout the area. The locality that has attracted most attention is on the west bank of Grass river about half a mile north of the narrows north of Crowduck bay. The molybdenite occurs in a pegmatite dyke that runs at right angles to the river and cuts a fine-grained dark coloured biotite gneiss. The dyke is 20 feet long and has a minimum width of 3½ feet. The pegmatite is composed of coarse orthoclase crystals and quartz, the quartz being so abundant in places that it resembles a true quartz vein. The dyke contains molybdenite, pyrite, and chalcopyrite. The molybdenite is concentrated in seams along the borders of the feldspar crystals, along the contact of the dyke and the country rock, and occurs also in the wall-rock for about half an inch from the dyke. Near the pegmatite dyke are a number of quartz veins, but none of them contain any molybdenite.

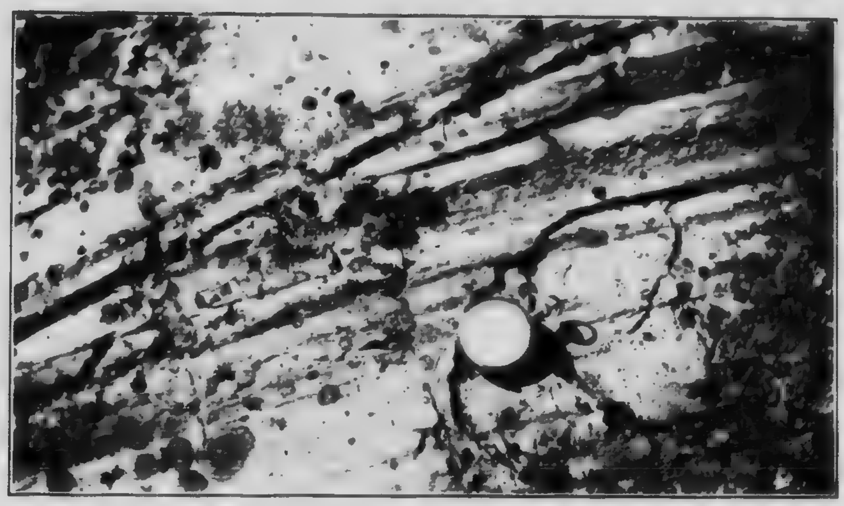
On the north arm of Herblet lake molybdenite has been found in quartz veins, but in only small quantities.

GALENA.

About a mile and a half from the west end of Snow lake a vein carrying considerable quantities of galena outcrops on the south shore. The gangue consists of white translucent quartz, but considerable amounts of a light greyish-white, coarse to fine crystalline, slightly ferruginous dolomite are also present. The galena, with which are sphalerite and small quantities of pyrite, is reported to carry values in silver, but the extent of the deposit exposed at present is very small.

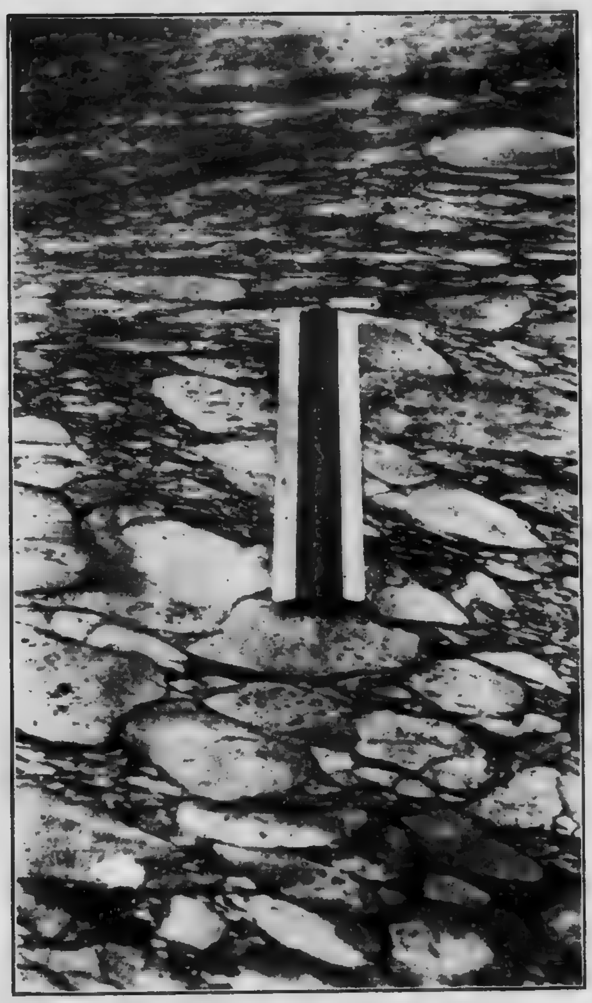
PLATE II.

A. Stoped granite border, Tramping lake. (Page 27.)



B. Crossbedding in quartzite, Stuart lake. (Page 23.)

PLATE III.



Acid pyroclastics, Wekusko lake. (Page 19.)

PLATE IV.

No. 1 vein, Kiski-Wekusko, Wekusko lake. (Page 36.)

PLATE V.

Stratified tuffs, showing glacial grooving, Wedges point, Wekusko lake. (Page 11.)

PLATE VI.

Indian relics from the region. (Page 13.)

a. Hammer, outlet of lake lying between Morton and Reed lakes.
b. Scraper, Goose lake.
c. Stone pipe, Goose river.
d. Fragment of pottery, Wedges point, Wekusko lake.

INDEX.

A2
Q
A3
R E X
A3
Mitishto
Shaft
A3
TP.64 R.15
Trail
Trail
A2
CANADIAN NATIONAL

Canada
Department of Mines

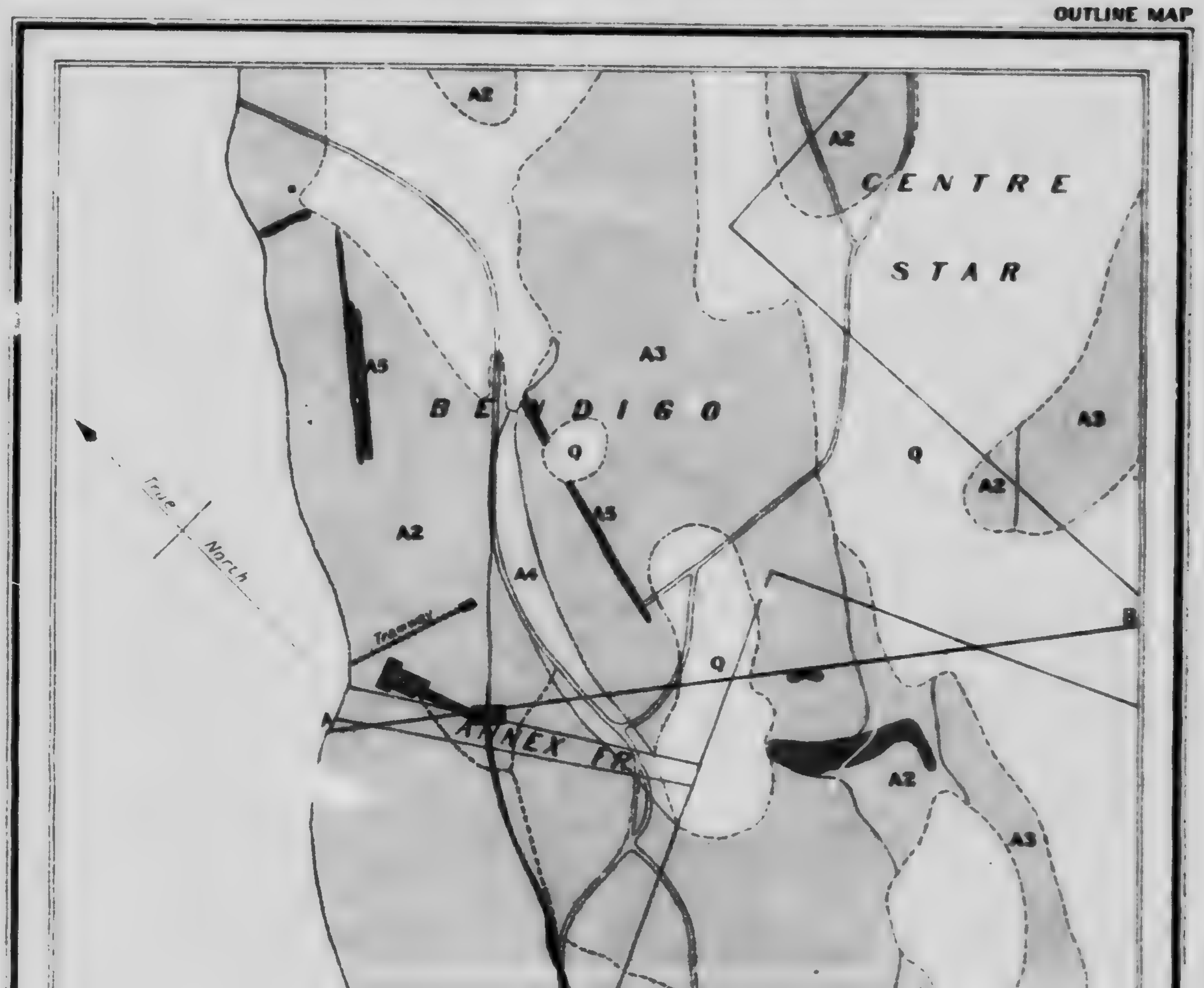
GEOLOGICAL SURVEY

William McInnes, Directing Geologist

Issued 1919

Diagrammatic section along line A B

OUTLINE MAP



LEGEND

QUATERNARY

Q — Drift and clay

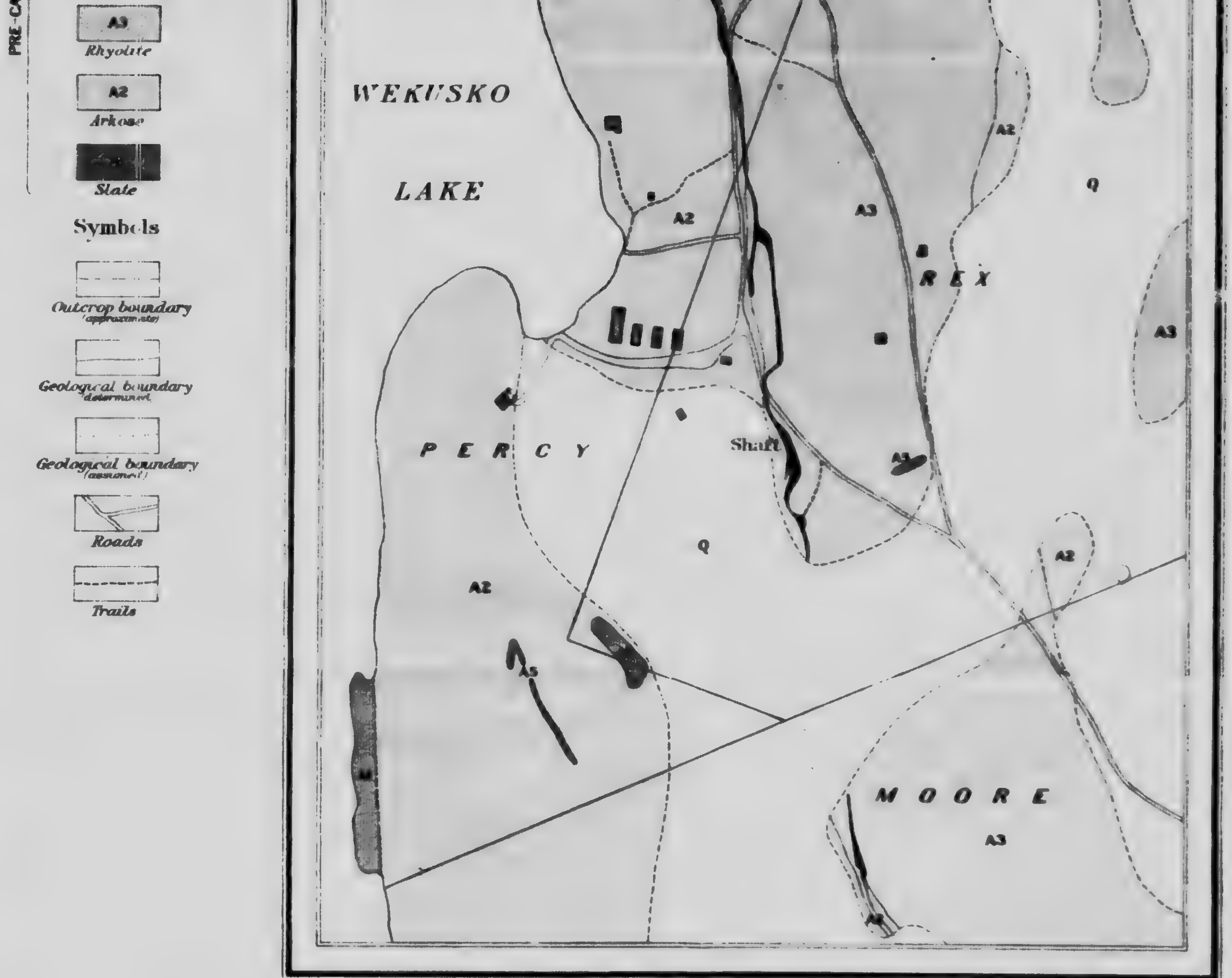
Vein

PRE-CAMBRIAN

Hornblende lamprophyre

A4 — Mica lamprophyre

A3 — Rhyolite



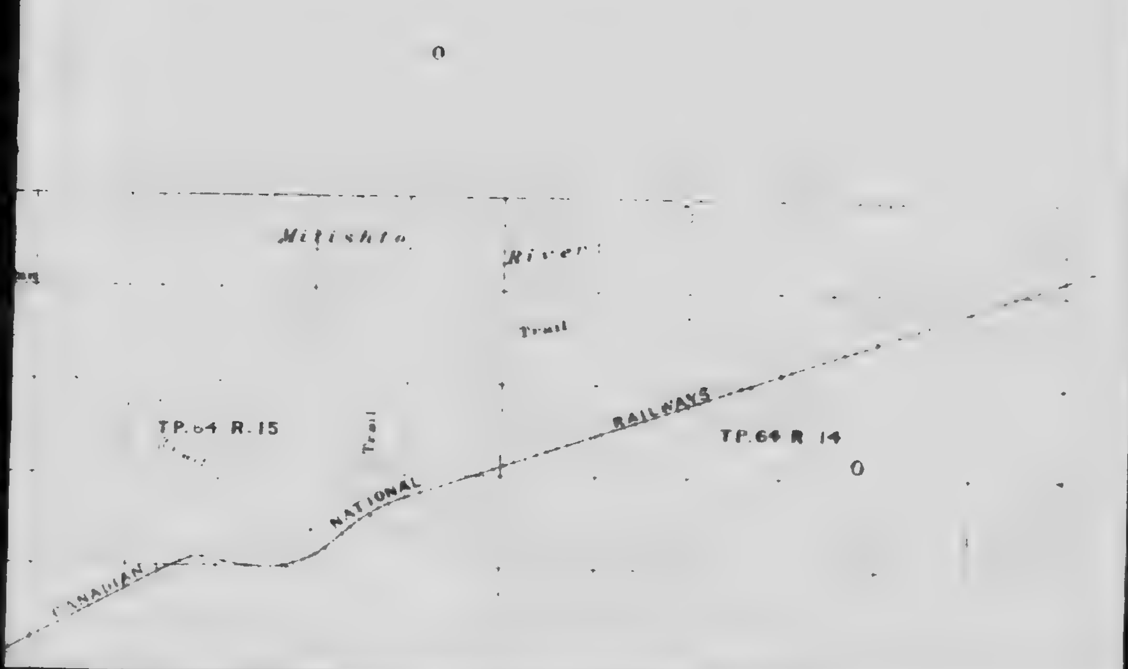
C-O Senécal, Geographer and Chief Draughtsman
J.O.Fortin, Draughtsman

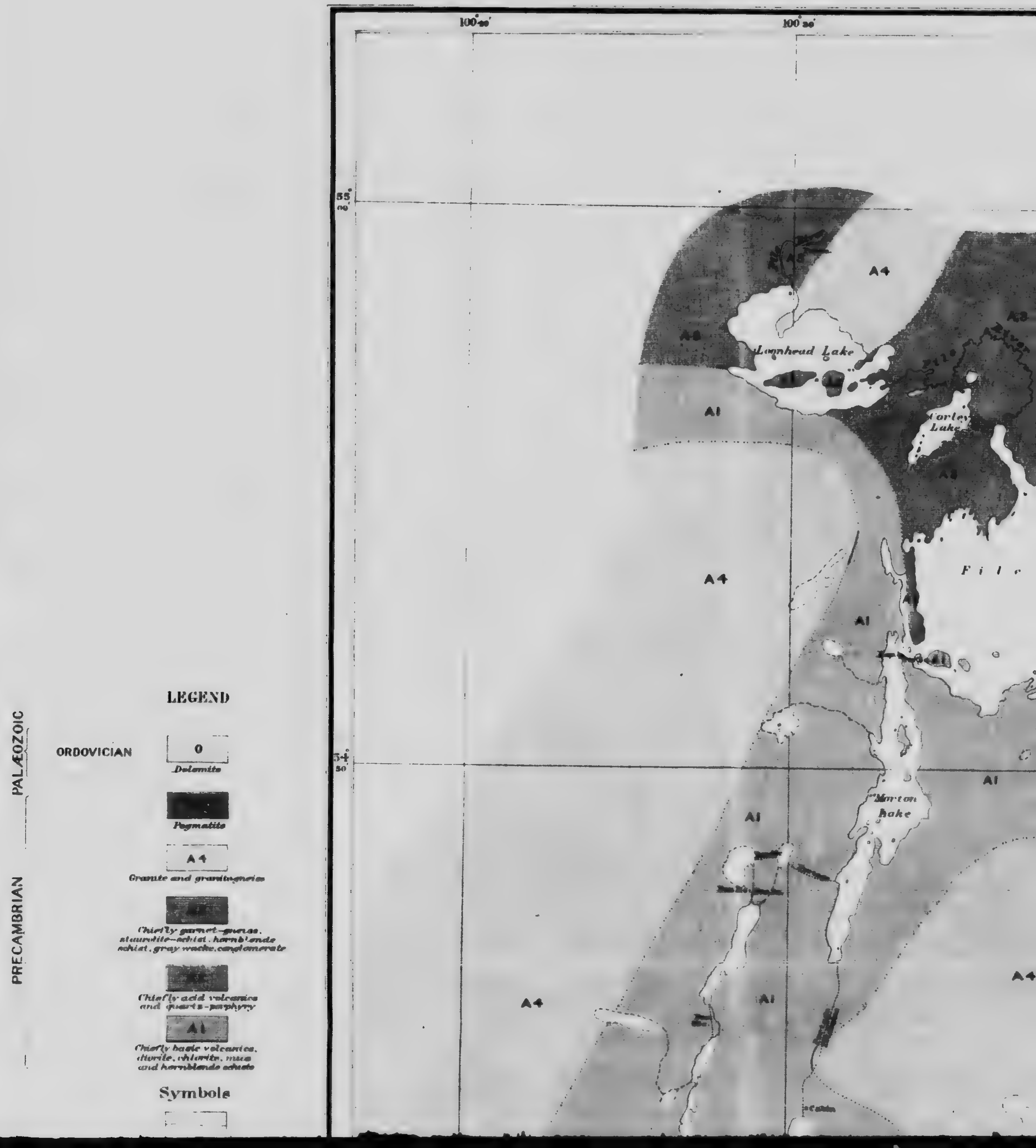
Publication N° 1763

PORTION OF THE REX GROUP OF CLAIMS,
WEKUSKO LAKE, MANITOBA.

Scale of Feet

To accompany memoir by F.J.Alcock


Mitishto
River
Trail
Trail
TP.64 R.15
TP.64 R 14
CANADIAN
NATIONAL
RAILWAYS

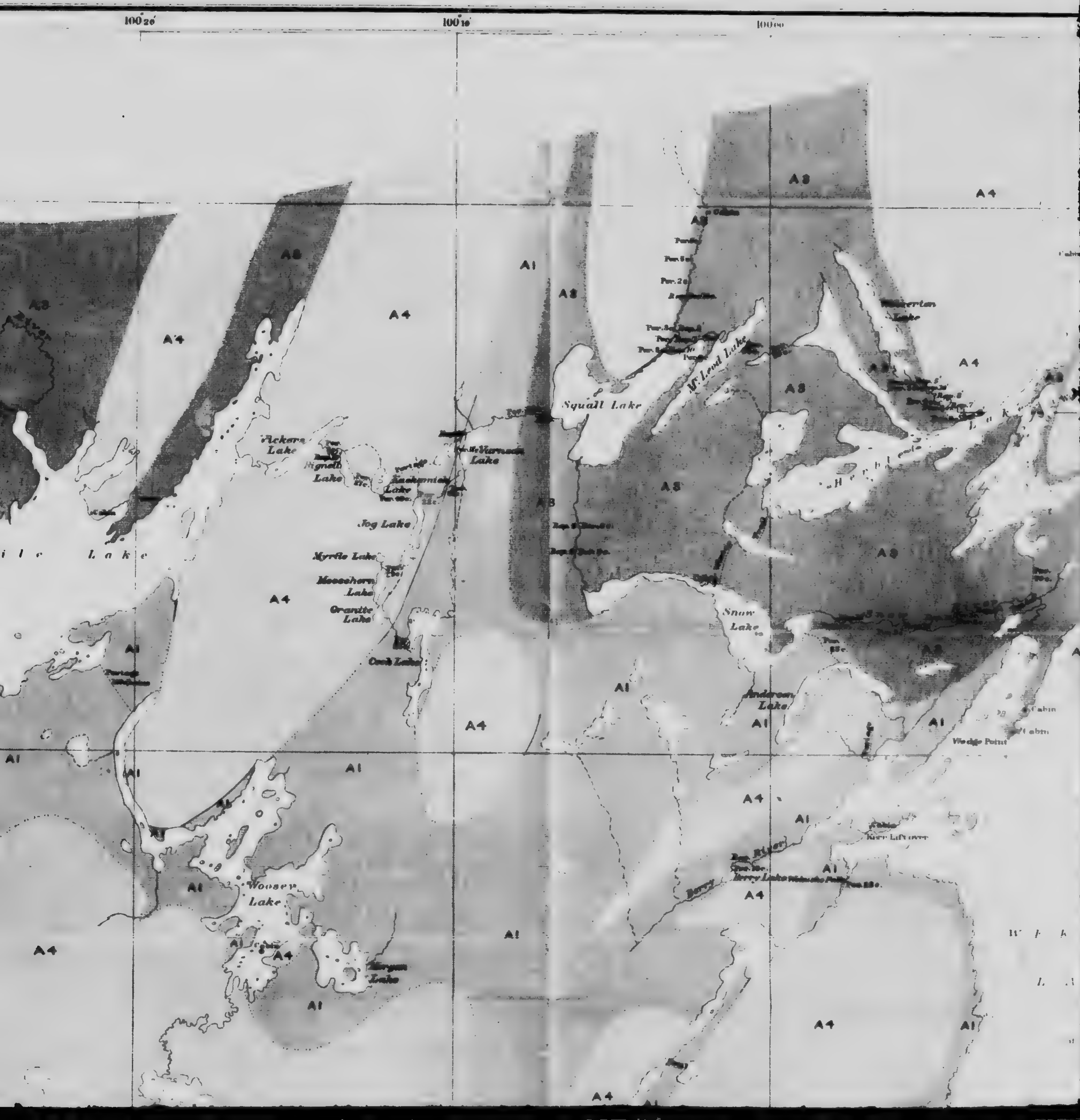


100°40'
100°30'
55° 00'
54° 50'
Loonhead Lake
Morton Lake
A4
A3
A1
LEGEND
PALÆOZOIC
ORDOVICIAN
0
Dolomite
Pegmatite
PRECAMBRIAN
A4
Granite and granitogneiss
Chiefly garnet-gneiss, staurolite-schist, hornblende schist, gray wacke, conglomerate
Chiefly acid volcanics and quartz-porphyry
A1
Chiefly basic volcanics, diorite, chlorite, mica and hornblende schists
Symbols

Canada
Department of Mines

GEOLOGICAL SURVEY

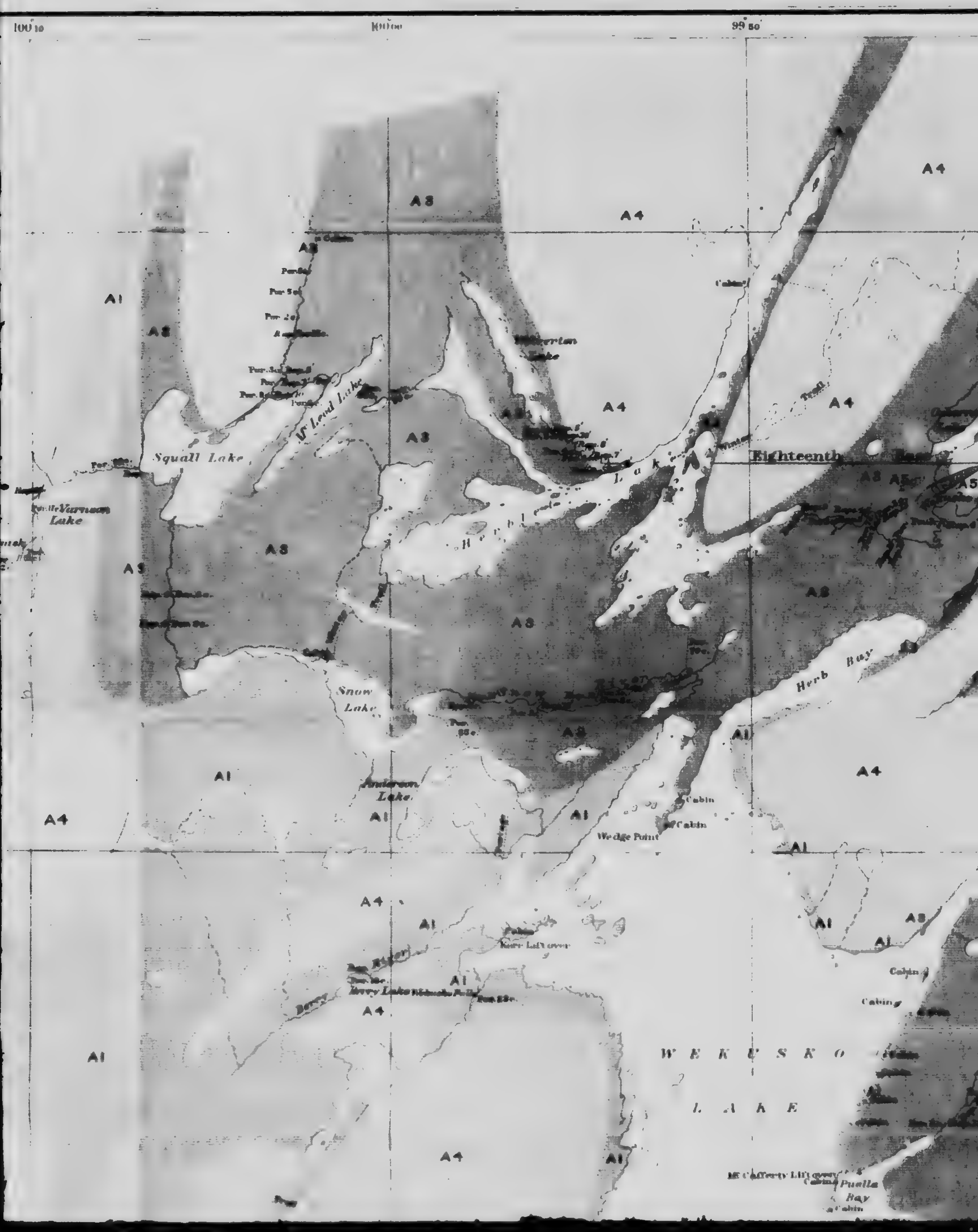
Issued 1920



Canada
Department of Mines

GEOLOGICAL SURVEY

Issued 1920



99°40
99°30
55°
00
54°
30
Line
River
Crowduck Bay
Niblock Lake
Grass River
Roberts Lake
Dion Lake
Burns Lake
A1
A3
A4
A5

Symbols

Geological boundary
(determined)

Geological boundary
(approximate)

Geological boundary
(assumed)

C.O. Senécal, Geographer and Chief Draughtsman
J.J. Carr, Draughtsman

Scale, 200 Miles to 1 inch

To accompany Memoir by F.J. Alcock

REED AND WEKUSKO LAKES REGION

MANITOBA

Scale, $\frac{1}{126.720}$

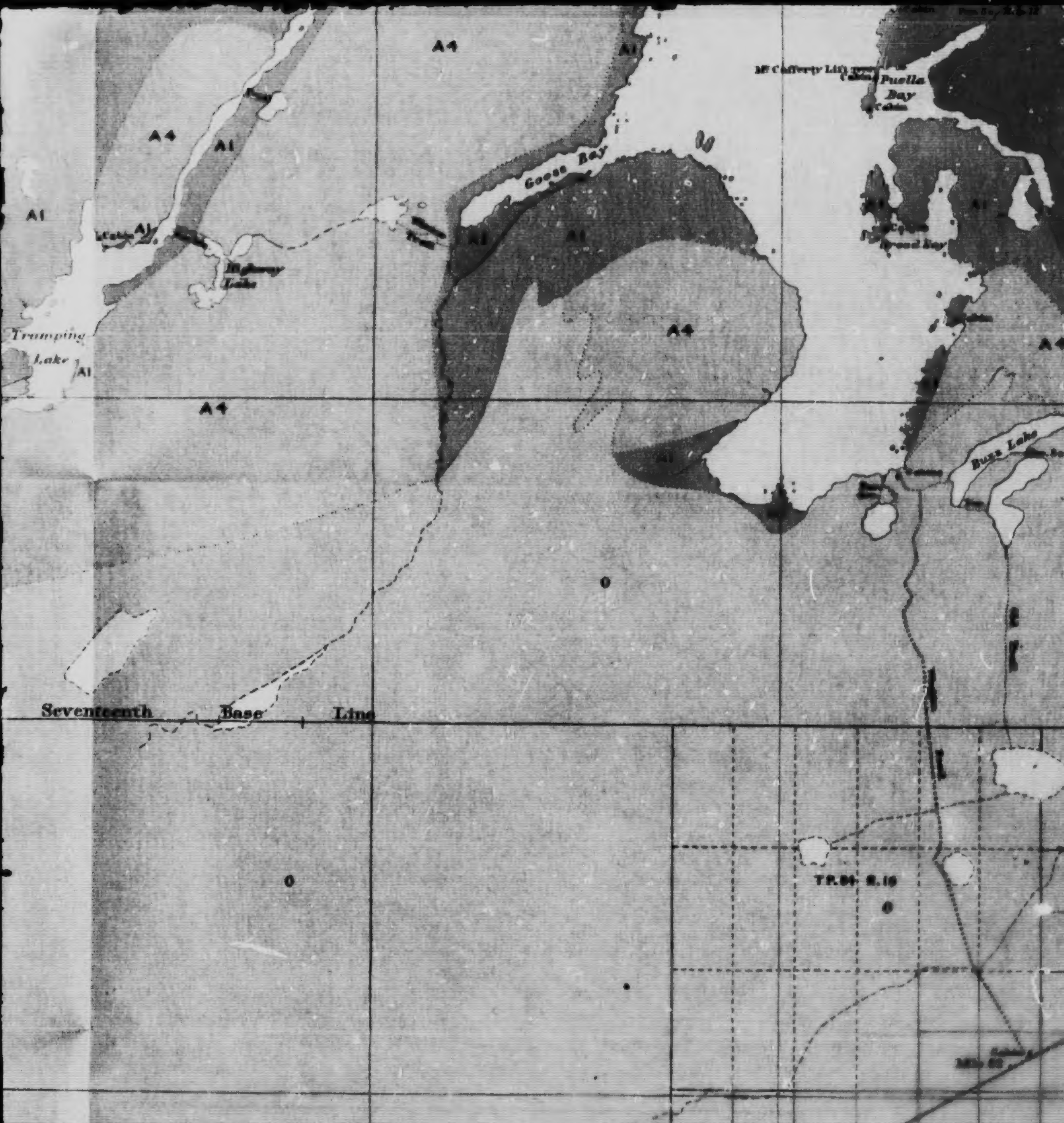
Miles

1 0 1 2 3 4 5

Kilometres

1 0 1 2 3 4 5 6 7 8 9 10

2 MILES TO 1 INCH



WEKUSKO LAKES REGION

MANITOBA

Scale $\frac{1}{126,720}$

Miles

Kilometres

2 MILES TO 1 INCH

Sources of Information

Geography from surveys by F.J. Alcock, E.L. Bruce, 1914–1916, and from official plans of the Department of the Interior.

Geology by F.J. Alcock and E.L. Bruce, 1914–1916

Map compilation by J.J. Carr.